ADMINISTRATIVE REPORT - FOR OFFICIAL USE ONLY

Mineral Resources of the West Mojave Area, Kern, San Bernardino, and Inyo Counties, California, Excluding the Randsburg-Searles Lake Area

By

R. M. Smith and H. K. Stager
U. S. Geological Survey, Menlo Park, Calif.

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INTRODUCTION

This report supplements the Randsburg-Searles Lake report of May 1974 by the same authors. It covers four adjoining areas. The total enlarged area--about 1.96 million acres--is herein called the West Mojave area; the part in Kern County is called the El Paso area; the part in San Bernardino County, the Red Mountain area; the part in Inyo County, the northern Searles Valley area. Supplemental portions are identified herein as El Paso West, Red Mountain North, Red Mountain South, and northern Searles Valley.

The supplemental areas include about 1,937 sections in the following 64 townships:

	MDBM		SBBM	
	Twp. S.	Rge. E.	Twp. N.	Rge. W.
El Paso West Kern County	25	37-39	11	7-12
	26	37-40	12	7-12
	27	36-40		
	28	35-37		
	29	35,36		
	30	35-36½		
	31	35-36½		
	31	37-40		
	32	35-40		
Red Mountain North San Bernardino County NO MINERAL DEPOSITS	26 (Secs. 34, 35, 36)	41		
Red Mountain South San Bernardino County	31	44	10	4-7
	32	44	11	4-7
			12	4-7
Northern Searles Valley Inyo County	23	42,43		
	24	42-44		

MAPS, LOGS, WELL DATA - Availability

Topographic maps of 21 quadrangles of the 15-minute series (1.014 inches = 1 mile) cover the total enlarged West Mojave area. Quadrangle names are shown on Figure 1. The 15-minute series of topographic maps is being replaced nationwide by the 7½-minute series (1:24,000 scale). After 7½-minute maps are published, and after a map in the 15-minute series becomes 30 years old, it is not reprinted except in special cases; existing stocks are given away or destroyed. Maps of the Randsburg, Saltdale, and Tehachapi quadrangles are more than 30 years old and have been discontinued. The 30-minute series has been abandoned entirely.

Aerial photographs at various scales (1:12,000 to 1:56,000) are available for areas shown on Figure 2 (status April 1973). USGS photos, U-2 photos, Skylab/Gemini/Apollo photos, and ERTS imagery may now (December 1974) be obtained by Bureau of Land Management directly through the EROS Data Center in Sioux Falls, South Dakota, on FTS 8-605-594-6151. To order, your account number is needed in addition to photo ID number and product type and size desired. Your administrative office may need to be advised of your order. Information on remote sensing applications is also available from the EROS Applications Assistance Facility in Menlo Park, California, on FTS 8-415-323-2727.

Topographic and orthophotoquad maps in preparation for which advance material is available as of July 1, 1974 are shown on Figures 3, 3A, and 4.

Aeromagnetic and aeroradioactivity maps of parts of the Mojave Desert region are available as indicated on Figures 4 and 5 and in Table 1, or from repositories listed at the end of Table 1.

Gravity stations and values are shown on the geologic map of the Slate Range by Smith and others (1968), and on the anomaly map of the Death Valley region, GP-305, by Mabey (1963). Gravity contours are shown on Figure 6 which is a portion of the gravity anomaly map of the United States by Woollard and Joesting (1964).

Areas for which data on water wells in California are available are illustrated on Figures 7 and 8. Publications by the U.S. Geological Survey covering the areas shown on Figure 7 are listed in Table 2.

Exploratory test holes drilled for minerals, oil and gas, and water in the western Mojave Desert region are listed by Dibblee (1967, p. 138-153). Of 129 holes drilled for minerals, 126 are in the El Paso-Red Mountain area; of 123 holes for oil, gas, or water, 33 are in the El Paso-Red Mountain area.

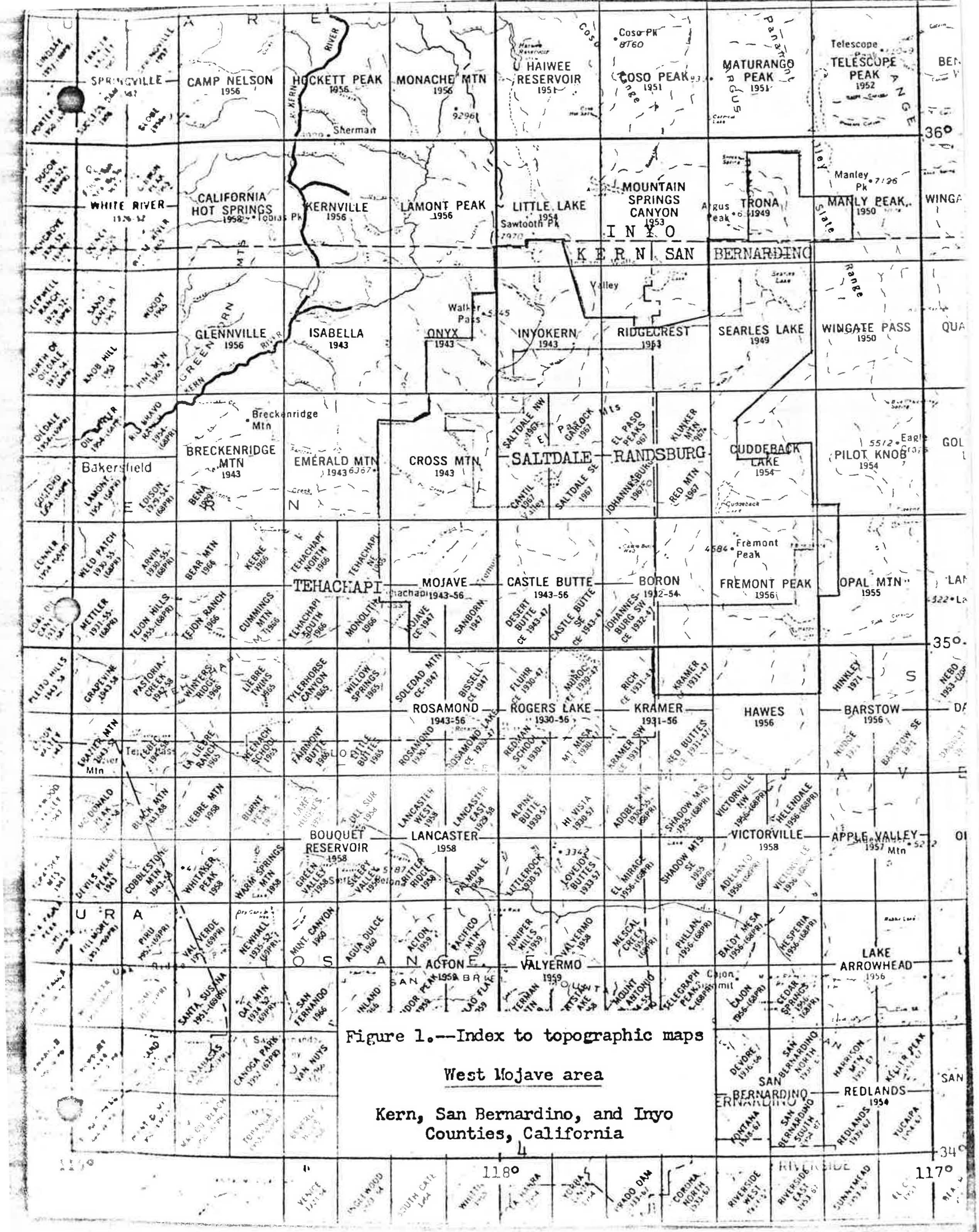


Figure 1.--Index to topographic maps

West Mojave area

Kern, San Bernardino, and Inyo Counties, California

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CALIFORNIA

TOPOGRAPHIC DIVISION
WESTERN MAPPING CENTER
MENLO PARK, CALIFORNIA

ADVANCE MATERIAL AVAILABLE FROM CURRENT TOPOGRAPHIC MAPPING QUARTERLY EDITION – OCT. 1, 1974

2	Aerial Photography completed. Information available from Western Mapping Center, U. S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025, or Map Information Office, U.S. Geological Survey, Washington, D.C. 20244.
3	Basic horizontal and vertical control surveys completed. Descriptions and unadjusted coordinates and/or elevations are available. Price is 50 cents for each 15-minute quadrangle horizontal or vertical control list. See Notes.
4	Prints of manuscripts compiled from aerial photographs are available at 75 cents each.
5	Field mapping and checking completed. One color unedited advance prints, with names and section corner data, are available for 75 cents each.
6	Final drafting completed. Partially edited one-color advance prints available for 75 cents each. (If shaded, see explanation below).
▨	Shaded areas indicate that maps have been published at 1:62,500-scale ONLY. However, 1:24,000-scale prints in 7.5-minute units, with appropriate accuracy and contour interval, are and will remain available. Each such print is 75 cents, or $3 for prints covering a complete 15-minute quadrangle.

NOTES:

1. Requests for all advance materials should be sent to Western Mapping Center, U. S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025. Payment in exact amount should accompany order and may be made by check or money order, payable to U. S. Geological Survey. Please do not send stamps. NO DISCOUNT ALLOWED.
2. In ordering materials or requesting information, mark the area of interest on this index and forward it with your order. A new copy of the index will be returned for your future use.

PUBLISHED MAPS

▣	**Maps published since latest edition [APRIL 1974] of Sales Index to published maps.**

Sales Index available free. Published maps available at 75 cents each from U. S. Geological Survey, Denver Distribution Section, Federal Center, Bldg. 41, Denver, CO 80225, and Distribution Section, U. S. Geological Survey, 1200 Sout Eads St., Arlington, VA 22202. On an or amounting to $300 or more at the list price, 30-percent discount is allowed; no other discount is applicable. Remittance may be made by check or money order payable to the U. S. Geological Survey.

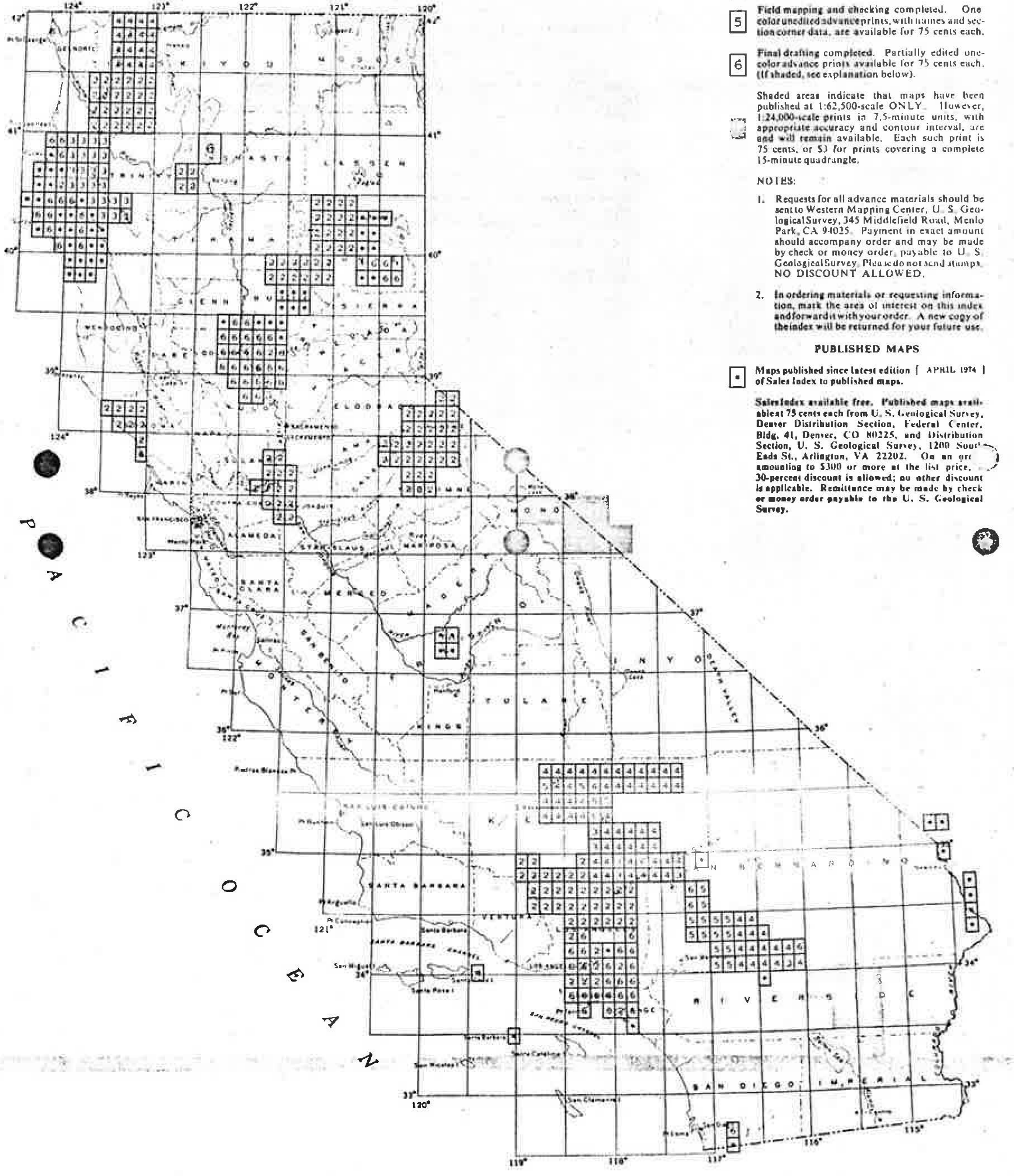


Figure 3.--Advance material - topographic mapping.

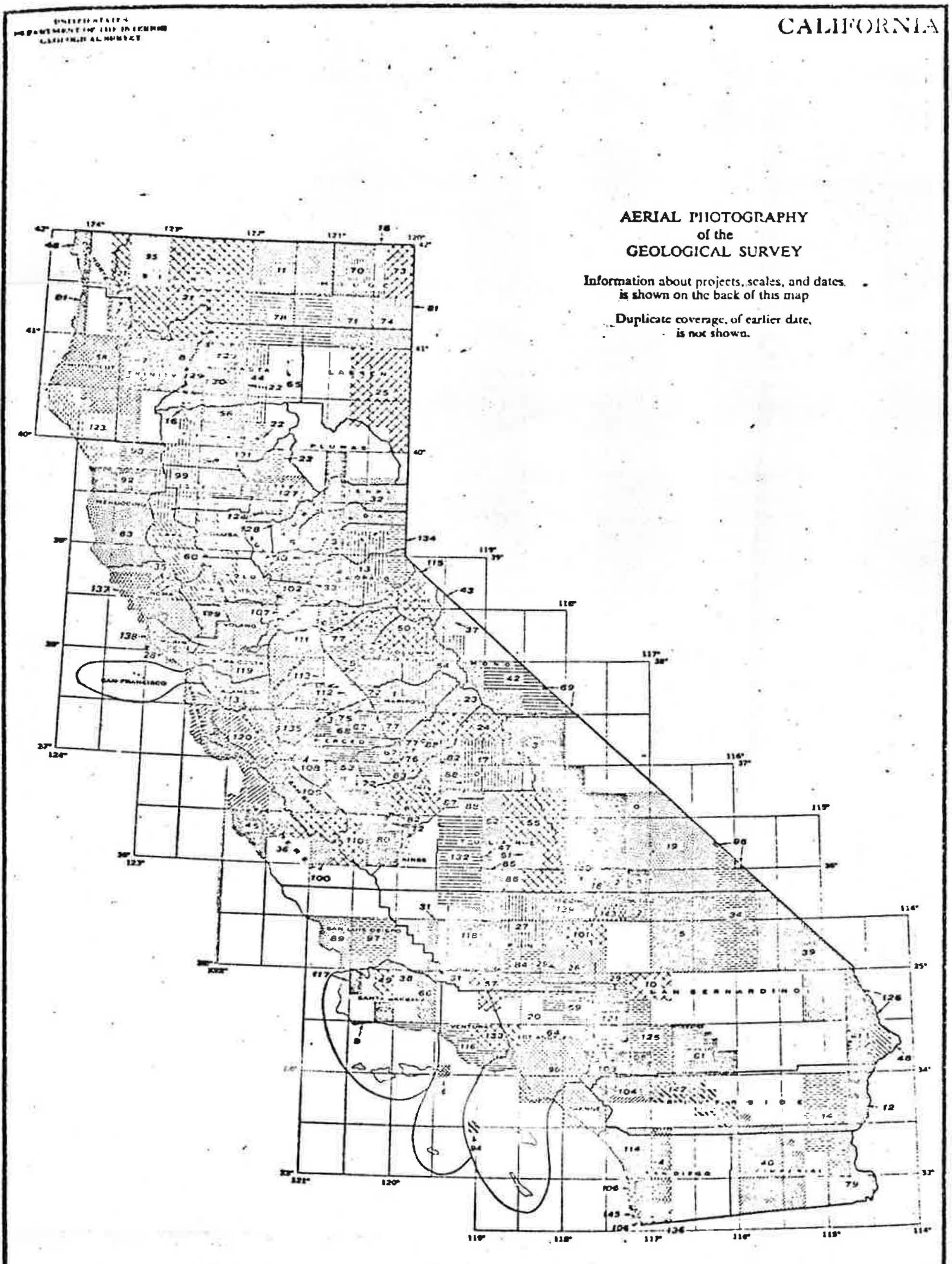


Figure 2

⬚ - West Mojave area

California

Prints from negatives held by the Geological Survey for the projects listed below may be obtained from Chief, Photo Section (Don Hopkins), National Cartographic Information Center, U.S. Geological Survey, National Center, Mail Stop 507, Reston, Virginia 22092. The date and scale of photography are shown as 65/24 = 1965 photography at 1:24,000 scale. The lens focal length is 6 inches, except as noted.

NO.	PROJ. SYMB.	DATE/SCALE	NO.	PROJ. SYMB.	DATE/SCALE	NO.	PROJ. SYMB.	DATE/SCALE	NO.	PROJ. SYMB.	DATE/SCALE
– 1	BS[3]	45/39	46	VIU	55/24	90	VASK	63/30	129	VCGY	69/35
– 2	CG[2]	46/56	47	VJH	55/42	91	S-VAXK[5]	64/18	130	VCGZ	69/30
– 3	CQ	46/37	48	VJJ	55/54	91	VAXK	64/36	131	VCHA	69/30
4	VCSQ	71/30	49	VJL	55/47	92	S-VBAG[5]	64/18	132	VCHB	69/30
5	CW	47/28	50	VJM	55/47	93	VBAG	64/34	133	VCHC	69/30
6	EG	47/31	51	VJN	55/34	94	VAWW	64/24	134	VCHH	69/30
7	EH	47/37	52	VJO	55/34	95	VAWW	64/30	135	VCTM	71/30
8	EI	47/37	53	VJR	55/24	96	VAXL	64/24	136	VCSQ	71/27
9	EM	47/24	54	VJS	55/47	97	VBAJ	64/24	137	VCUM	71/36
10	VCMN	70/24	– 55	VJZ	55/47	97	VBAJ	64/34	137	VCUM	71/24
11	ECA[2]	48/27	56	VKC	55/20	98	VBGG	65/24	138	VCUN	71/30
12	VCMM	70/30	57	VKQ	56/24	99	VBGG	65/36	– 139	VCSP	71/24
13	EK	48/43	58	VLI	56/37	100	VBGY	65/32	– 139	VCSP[1]	71/34
14	HA	48/56	59	VLW	56/24	– 101	VBGZ	65/32	– 140	VCSP	71/12
15	HM	48/47	60	VNS	57/37	102	VBML	66/24	141	VCYZ	72/30
16	HN	48/47	60	VNS	57/47	103	VBNF	66/24	142	VCWE	72/30
17	HP	48/47	61	VCMJ	70/35	104	VBNF	66/30	– 143	VCSP	71/24
– 18	HQ	48/47	62	VQB	57/49	105	VBNF	66/34	– 144	SWGB[1]	72/21
19	IF	48/47	63	VQV	57/49	106	VBOI	66/24			
20	IG[4]	48/20	64	VRA	57/49	107	SWBH[1]	67/19			
21	PM	51/47	65	VRK	57/30	108	VBRH	67/24			
22	QE	51/37	66	VRM	58/48	109	VBRH	67/34			
23	QN	51/47	67	VRU	58/24	110	VBSM	67/34			
24	QQ	51/47	68	VRU	58/30	110	VBSM	67/36			
25	RG	51/47	69	VRZ	58/48	111	VBSY	67/24			
– 26	QS	52/37	70	VTO	58/20	112	VBSZ	67/24			
27	VCML	70/24	71	VTY	58/34	113	VBSZ	67/30			
28	UX	52/24	72	VUK	58/30	114	VBTA	67/32			
– 29	UY	52/24	73	VVL	59/34	115	VBTC	67/24			
30	WJ	52/24	74	VVM	59/34	116	VBUK	67/30			
31	WK	52/24	75	VYU	59/20	117	VBIV	67/24			
32	VAD	53/37	76	VYU	59/24	118	VBZI	68/30			
33	WF	53/33	77	VYU	59/40	119	VBZJ	68/30			
34	YA	53/47	78	VADD	60/35	120	VBZK	68/30			
35	YD	53/24	79	VAKJ	61/24	121	VBZL	68/30			
36	YG	53/24	80	VCSM	71/30	122	VBZL	68/34			
37	YN	53/37	81	VAMO	62/20	123	VBZX	68/34			
38	YO	53/37	82	VAMS	62/24	124	SWCZ[1]	69/21			
39	YP	53/47	83	VAMS	62/30	125	VCGN	69/24			
40	YQ	53/24	84	VAMU	63/40	125	VCGN	69/34			
41	VCMK	70/24	85	VARX	65/22	126	VCFL	69/24			
42	VDL	54/37	86	VARX	63/32	126	VCFL	69/34			
43	VEV	54/37	87	VASC	63/24	127	VCGO	69/24			
44	VFC	54/47	88	VASG	63/34	128	VCGO	69/30			
45	YH	54/37	89	VASJ	63/24	129	VCGY	69/24			

[1] Focal length 3.5 inches.

[2] Focal length 4 inches.

[3] Focal length 5.2 inches.

[4] Focal length 8.25 inches.

[5] Focal length 12 inches

Figure 2.--Continued

(p. 6 follows)

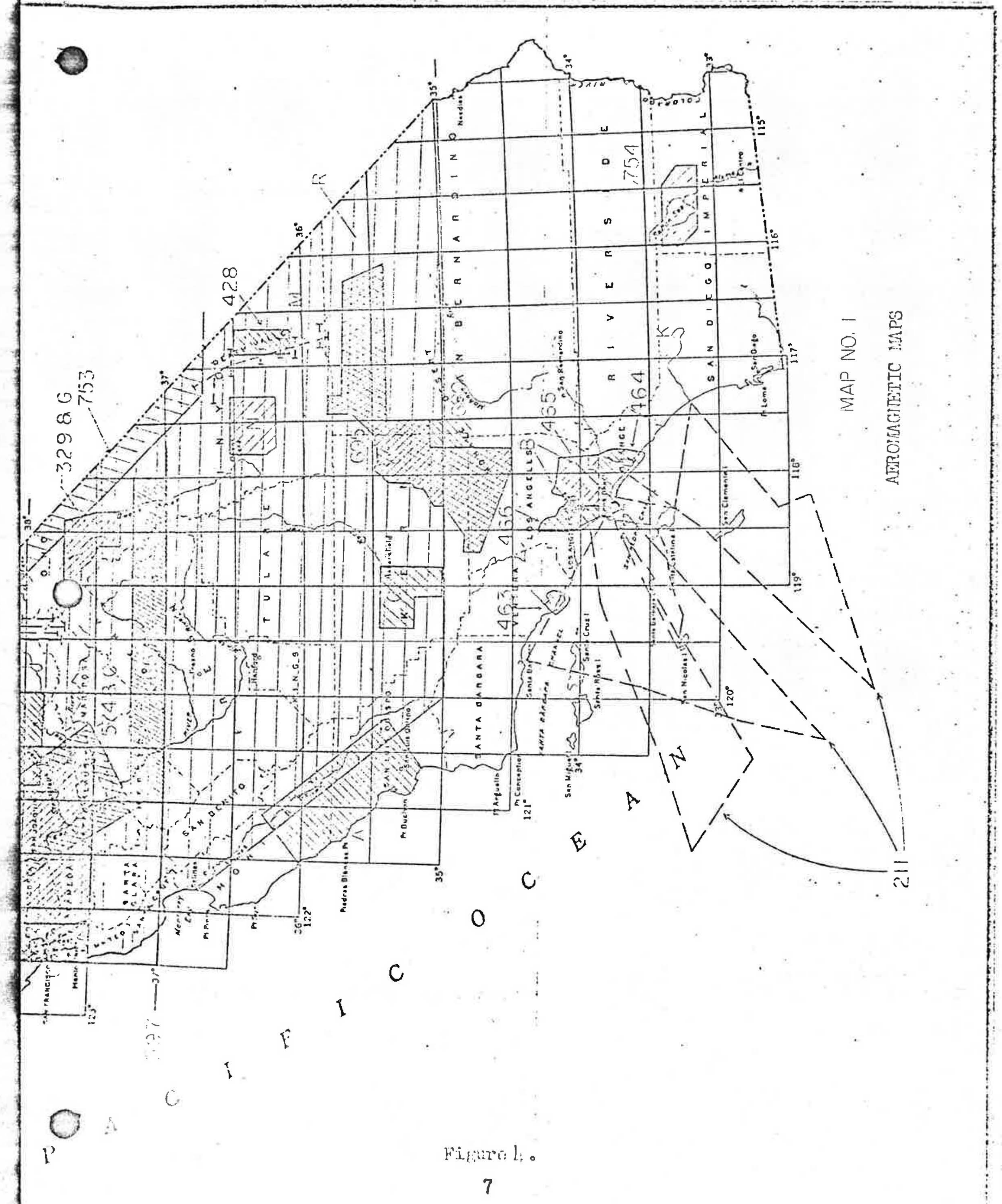
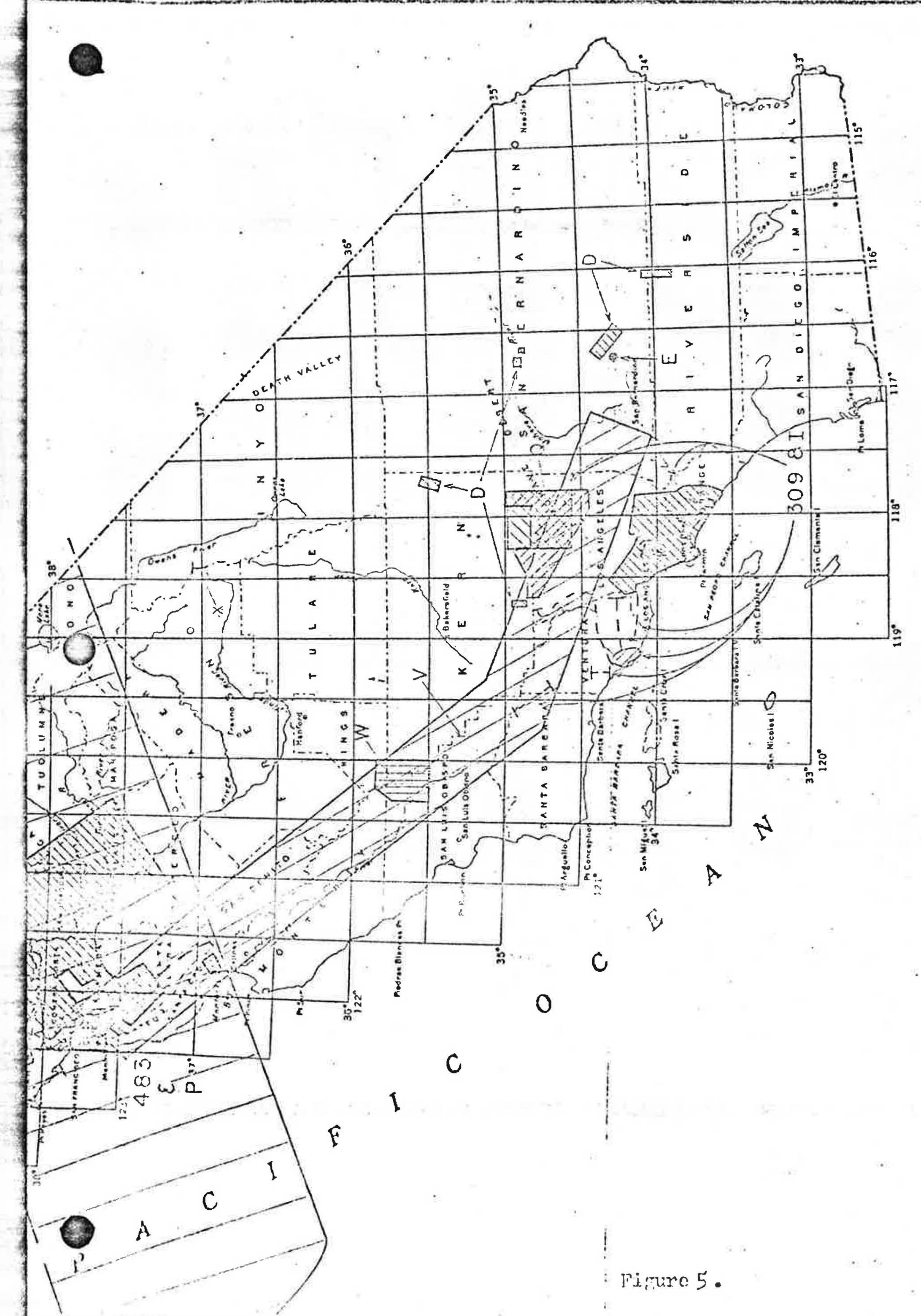

MAP NO. 1
AEROMAGNETIC MAPS
3298 G
753
428
R
M
H
754
K
465
464
466
463
5436
211
P A C I F I C O C E A N
SAN BERNARDINO
RIVERSIDE
SAN DIEGO
IMPERIAL
LOS ANGELES
ORANGE
VENTURA
SANTA BARBARA
SAN LUIS OBISPO
MONTEREY
SAN BENITO
SANTA CLARA
FRESNO
TULARE
KINGS
KERN
INYO
Needles
San Bernardino
San Diego
Pt Loma
El Centro
Bakersfield
Santa Barbara
Pt Conception
Pt Arguello
San Miguel I
Santa Rosa I
Santa Cruz I
San Nicolas I
Santa Catalina
San Clemente
Monterey
San Francisco
Piedras Blancas Pt
Pt Buchon
115°
116°
117°
118°
119°
120°
121°
122°
123°
33°
34°
35°
36°
37°
38°

Figure 4.



MAP NO. 2

AERORADIOACTIVITY MAPS

Figure 5.

Table 1. Aeromagnetic and Aeroradioactivity maps

CALIFORNIA

U. S. GEOLOGICAL SURVEY
MENLO PARK
AUG 15 1973
LIBRARY

Map ref.

Aeromagnetic and gravity features of the western Franciscan and Salinian basement terranes between Cape San Martin and San Luis Obispo, Calif., by W. F. Hanna, 1970, in Professional Paper 700-E, p. 66-77, $3.25....... A

OM 117 The floor of the Los Angeles basin, Los Angeles, Orange, and San Bernardino Counties, by J. R. Schoellhamer and A. O. Woodford, 1951, (has two aeromagnetic profiles in Los Angeles County), 75 cents.......... B

Magnetic data and regional structure in northern California, by Andrew Griscom, 1966, in Bailey, E. H. editor, Geology of northern California: Calif. Div. of Mines and Geol. Bull. 190, p. 407-417 (fig. 2 shows seaward extension of the San Andreas fault (from Gulf Research and Development Co. data), fig. 3 is a simplified version of GP-574, fig. 4 is an aeromagnetic map with generalized geology of the Bakersfield area)....... C

Airborne radioactivity survey in the Mojave Desert region, Kern, Riverside, and San Bernadino Counties, California, by R. M. Moxham, 1952, (TEMR 360). Available from Photo Duplicating Service, Library of Congress, Washington, D. C., 20540, $3.00 for microfilm copy, $6.30 for photographic copy.. D ✓

* Bulletin 1021-C Geologic and airborne radioactivity studies in the Rock Corral area, San Bernardino County, California, by R. M. Moxham, G. W. Walker, and L. H. Baumbardner, 1955 .... E

* Possible significance of broad magnetic highs over belts of moderately deformed sedimentary rocks in Alaska and California, by Arthur Grantz and Isidore Zietz, in Professional Paper 400-B, 1960, p. 342-347 .... F

* Professional Paper 438 Structural geology and volcanism of Owens Valley region, California - a geophysical study, by L. C. Pakiser, M. F. Kane, and W. H. Jackson, 1964, (aeromagnetic data shown on pl. 2 and fig. 16, p. 40) .... G

* Magnetic anomalies and ultramafic rock in northern California, by W. P. Irwin and G. D. Bath, in Professional Paper 450-B, p. 65-67, 1962, (fig. 25.1, p. 66 shows aeromagnetic profiles (A-H) and part of aeromagnetic contours from reference F.) .... H

CEX-59.4.16 Aeroradioactivity survey and related surface geology of parts of the Los Angeles region, California (ARMS-I), by K. G. Books, 1962, published by the U. S. Atomic Energy Commission, available from the U. S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, Va. 22151 $6.00 I

Bulletin 1261-G Mineral resources of the Emigrant Basin primitive area, California, by E. W. Tooker, H. T. Morris, and P. V. Fillo with a section on Geophysical studies by H. W. Oliver, 1970, (pl. 1 is a geologic-aeromagnetic map, scale 1:62,500), $1.00.............................. J

*Out-of-print

Map ref.

Bulletin 1319-A Mineral resources of the Agua Tibia Primitive Area, California, by W. P. Irwin, R. C. Greene, and H. K. Thurber, 1970, (pl. 1 is a geologic-aeromagnetic map with an aeromagnetic profile, scale 1:48,000), 65 cents .... K

Geophysical investigation of Mono Basin, California, by L. C. Pakiser, Frank Press, and M. F. Kane, 1960, Bulletin of the Geol. Society of America, v. 71, p. 415-448, (figs. 12-15, p. 436-439 show analysis of aeromagnetic profiles) L

*Professional Paper 494-A Stratigraphy and structure of Death Valley, California, by C. B. Hunt and D. R. Mabey, 1966, (fig. 83, p. 109 shows 7 aeromagnetic profiles) .... M

*Regional magnetic and gravity anomalies in the Darwin area, California, by D. R. Mabey, _in_ Professional Paper 424-C, 1961, p. 276-279 (fig. 249.1.A is an aeromagnetic map of the Darwin area with generalized geology) .... N

Aeromagnetic map of the southern part of the San Francisco Bay region, California, by U.S. Geol. Survey, scale 1:125,000 (OF 1971) .... O
Copies on file at 1, 2, 3, 7, 8, 9, 10.
Reproductions may be ordered from 2, 3, or 8.

CEX-59.4.5 Aeroradioactivity survey and related surface geology of parts of the San Francisco region, California (ARMS-I) by K. G. Books, 1966, published by the U. S. Atomic Energy Commission, available from the U. S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, Va. 22151, $6.00 .... P

*Professional Paper 516-F Airborne measurements of terrestrial radioactivity as an aid to geologic mapping, by J. A. Pitkin, 1968, (fig. 23 shows aeroradioactivity and geology of part of the western Mojave Desert) .... Q ✓

Misc. Geol. Invest. Map I-532-A Magnetic map from 112° W longitude to the coast of California, by Isidore Zietz and J. R. Kirby, 1968, scale 1:1,000,000, contour interval 100 gammas (coverage in Calif. is a combination of data from U. S. Naval Oceanographic Office and U.S. Geol. Survey), 50 cents .... R

Aeromagnetic investigation of crustal structure for a strip across the western United States, by Isidore Zietz and others, 1969, Geol. Soc. America Bull., v. 80, no. 9, p. 1703-1714 (pl. 1 shows tectonic features, aeromagnetic map with contour intervals of 20 and 100 gammas, and location of major magnetic trends and patterns) .... S

*Out-of-print

CALIFORNIA (contd)

	Map ref.
Bulletin 1371-A Mineral resources of the High Sierra Primitive Area, California, by J. G. Moore and L. Y. Marks, with a section on Aeromagnetic interpretation by H. W. Oliver, 1972, 40 p. (pl. 1 contains aeromagnetic contours, scale 1:62,500), $1.00	T
Bulletin 1371-B Mineral resources of the Salmon-Trinity Alps Primitive Area, California, by P. E. Hotz and others, with a section on An aeromagnetic survey and interpretation by Andrew Griscom, 1972, 267 p. (pl. 1 contains aeromagnetic contours, scale 1:125,000), $3.75	U
Gravity and magnetic data in the vicinity of the Calaveras, Hayward, and Silver Creek faults near San Jose, California, by S. L. Robbins, 1971, in Professional Paper 750-B, p. 128-139 (fig. 4 shows 7 aeromagnetic profiles), $3.50	V
Professional Paper 646-C Gravity, magnetics, and geology of the San Andreas fault area near Cholame, California, by W. F. Hanna, S. H. Burch, and T. W. Dibblee, Jr., 1972 (1973), 29 p. (pl. 1 has aeromagnetic contours, scale 1:62,500), $3.05	W
GP-211 Reconnaissance airborne magnetometer survey off southern California, by R. W. Bromery, K. O. Emery, and J. R. Balsley, Jr., 1960, 50 cents	211
GP-309 Natural gamma aeroradioactivity of parts of the Los Angeles region, California, by K. G. Books, 1962, scale 1:250,000, 50 cents	309
GP-329 Aeromagnetic map of Long Valley and northern Owens Valley, California, by J. R. Henderson, B. L. White and others, 1963, scale 1:62,500, 50 cents	329
GP-428 Aeromagnetic map of the east-central part of the Death Valley National Monument, Inyo County, California, by G. E. Andreasen and F. A. Petrafeso, 1963, scale 1:62,500, 50 cents	428

Aeromagnetic maps listed below are at 1:48,000 scale, priced at 50 cents each, and are by G. E. Andreasen, J. A. Pitkin, and F. A. Petrafeso:

GP-463 Oxnard and vicinity, Ventura County, California, 1964...	463
GP-464 The Long Beach-Santa Ana area, Los Angeles and Orange Counties, California, 1964	464
GP-465 Eastern Los Angeles and vicinity, California, 1964	465
GP-466 Western Los Angeles and vicinity, California, 1964	466

CALIFORNIA (contd)

	Map ref.
GP-483 Natural gamma aeroradioactivity map of parts of the San Francisco region, California, by K. G. Books, 1965, scale 1:250,000, 75 cents	483
GP-561 Aeromagnetic map of parts of the Mother Lode gold and Sierra Foothills copper mining districts, California and its geologic interpretation, by J. R. Henderson, A. A. Stromquist, and Anna Jesperson, 1966, scale 1:62,500, 75 cents	561
GP-574 Aeromagnetic map of Sacramento and vicinity, California, by J. L. Meuschke, J. A. Pitkin, and W. C. Smith, 1966, scale 1:250,000, 50 cents	574
GP-597 Aeromagnetic and gravity profiles of the United States along the 37th parallel, by Isidore Zietz and J. R. Kirby, 1967, scale 1:2,500,000, 50 cents	597
GP-657 Aeromagnetic strip map across the central Sierra Nevada, California, 1969, scale 1:125,000, 50 cents	657
GP-671 Aeromagnetic map of the northern Mother Lode area, California, 1969, scale 1:62,500, 50 cents	671
GP-680 Aeromagnetic map of parts of the Kramer and Boron quadrangles, southeastern California, 1970, scale 1:62,500, 50 cents	680 ✓
GP-695 Aeromagnetic map of Antelope Valley and part of the Garlock fault zone, south-central California, scale 1:250,000, 50 cents	695 ✓
GP-751 Aeromagnetic map of parts of the Walker Lake, Reno, Chico, and Sacramento 1° by 2° quadrangles, Nevada-California, by U.S. Geol. Survey, 1971, scale 1:250,000, $1.00	751
GP-753 Aeromagnetic map of parts of the Goldfield, Mariposa, and Death Valley 1° by 2° quadrangles, Nevada-California, by U.S. Geol. Survey, 1971, scale 1:250,000, $1.00	753
GP-754 Aeromagnetic map and interpretation of the Salton Sea geothermal area, California, by Andrew Griscom and L. J. P. Muffler, 1971, scale 1:62,500, $1.00	754
GP-815 Aeromagnetic reconnaissance and generalized geologic map of the San Andreas fault between San Francisco and San Bernardino, California, by W. F. Hanna and others, 1972, scale 1:250,000, 75 cents	815

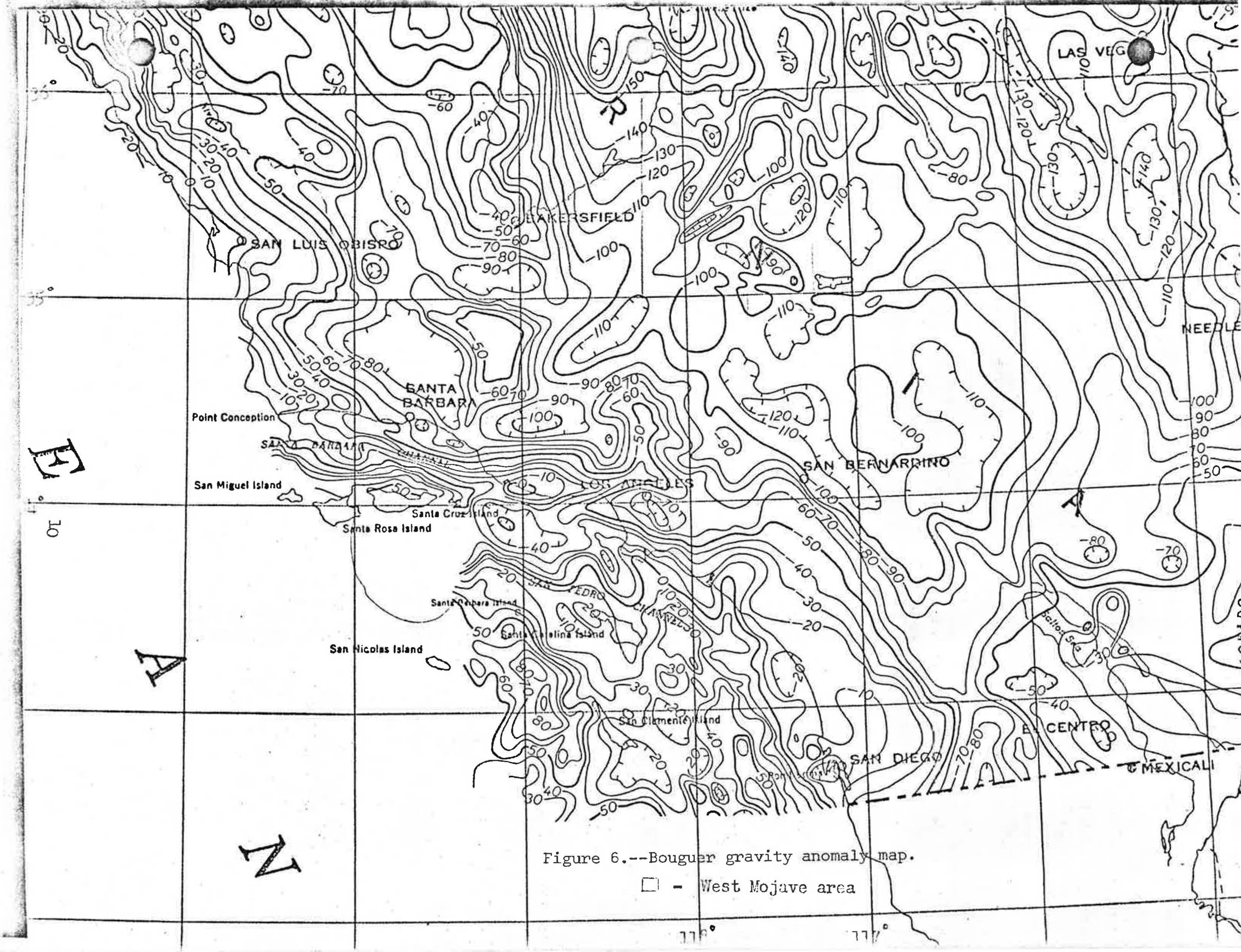


Figure 6.--Bouguer gravity anomaly map.

☐ - West Mojave area

CALIFORNIA (contd)

1. U.S.G.S. Library, National Center, Mail Stop 950, 12201 Sunrise Valley Drive, Reston, Virginia 22092
2. Rm. 7638 Federal Bldg., 300 N. Los Angeles St., Los Angeles, California
3. Rm. 504 Custom House, 555 Battery St., San Francisco, California
4. Rm. 8102 Federal Office Bldg., 125 S. State St., Salt Lake City, Utah
5. Library, Mackay School of Mines, University of Nevada, Reno, Nevada
6. Rm. 1012, Federal Bldg., Denver, Colorado
7. California Div. of Mines and Geology Library, Ferry Bldg., San Francisco, California
8. U.S.G.S. Library, 345 Middlefield Road, Menlo Park, California
9. U.S.G.S. Library, Bldg. 25, Federal Center, Denver, Colorado
10. State Office Bldg., 107 S. Broadway, Los Angeles, California

(p. 10 follows)

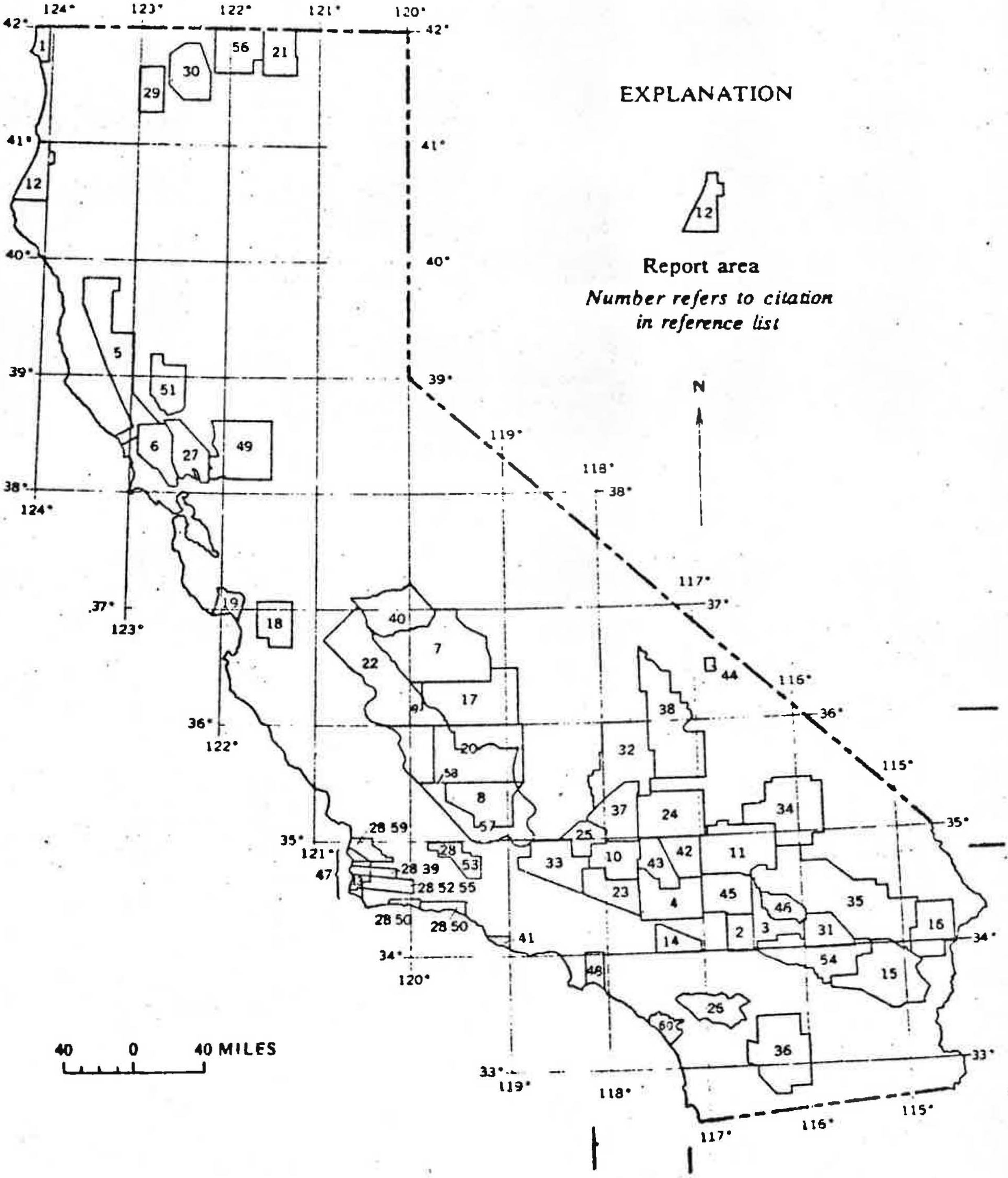


Figure 7.

FIGURE 1.--Areas for which well data are available.
Water wells

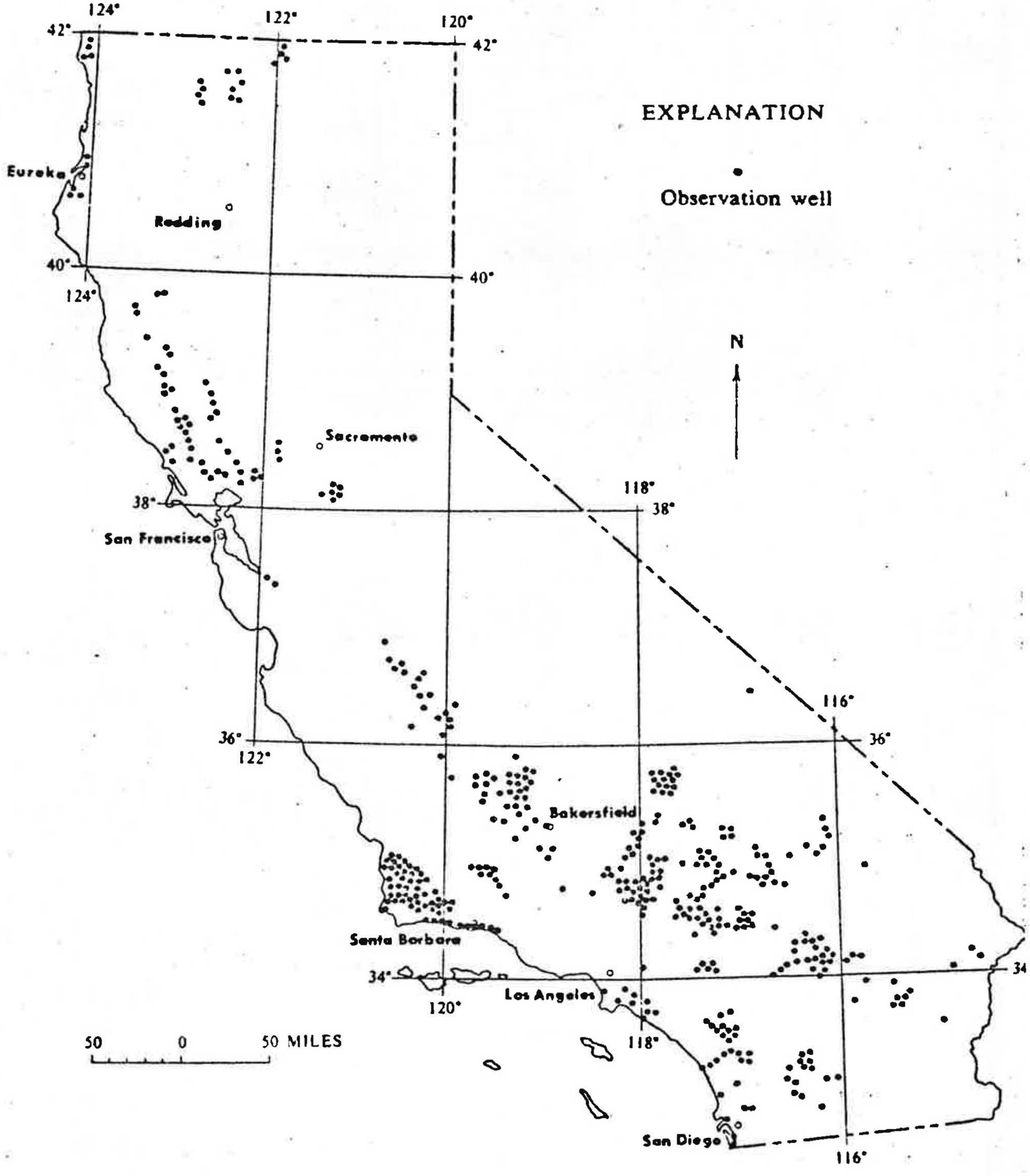


Figure 8.

FIGURE 2.--Selected observation wells.

Water wells

Bader, 1969

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27 KUNKEL, FRED, AND UPSON, J. E., 1960, GEOLOGY AND GROUND WATER IN NAPA AND SONOMA VALLEYS, NAPA AND SONOMA COUNTIES, CALIFORNIA: U.S. GEOL. SURVEY WATER-SUPPLY PAPER 1495, 252 P.

28 LA ROCQUE, G. A., JR., AND OTHERS, 1950, WELLS AND WATER LEVELS IN PRINCIPAL GROUND-WATER BASINS IN SANTA BARBARA COUNTY, CALIFORNIA: U.S. GEOL. SURVEY WATER-SUPPLY PAPER 1068, 459 P.

29 MACK, SEYMOUR, 1958, GEOLOGY AND GROUND-WATER FEATURES OF SCOTT VALLEY, SISKIYOU COUNTY, CALIFORNIA: U.S. GEOL. SURVEY WATER-SUPPLY PAPER 1462, 98 P.

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33 MOYLE, W. R., JR., 1965, WATER WELLS IN THE WESTERN PART OF THE ANTELOPE VALLEY AREA, LOS ANGELES AND KERN COUNTIES, CALIFORNIA: CALIFORNIA DEPT. WATER RESOURCES BULL. 91-11, 16 P., 6 APP.

34 MOYLE, W. R., JR., 1967, WATER WELLS AND SPRINGS IN SODA, SILVER, AND CRONISE VALLEYS, SAN BERNARDINO COUNTY, CALIFORNIA: CALIFORNIA DEPT. WATER RESOURCES BULL. 91-13, 16 P., 5 APP.

Table 2.--Continued

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37 MOYLE, W. R. JR., 1969, WATER WELLS AND SPRINGS IN THE FREMONT VALLEY AREA, KERN COUNTY, CALIFORNIA: CALIFORNIA DEPT. WATER RESOURCES BULL. 91-16.

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(p. 14 follows)

Table 3.--Geologic maps
West Mojave area

Inyo, Kern, and San Bernardino Counties, California

Quadrangle 15-minute series	Author	Publisher
Boron	Dibblee, 1958 USGS, 1970 (aeromagnetic)	U.S. Geol. Survey MF-204 U.S. Geol. Survey GP-680
Castle Butte	Dibblee, 1958	U.S. Geol. Survey MF-170
Cross Mountain SE¼	Dibblee, 1953 Samsel, 1962	Unpublished Calif. Div. Mines and Geology Map Sheet 2
Cuddeback Lake	G. I. Smith, 1964 G. I. Smith, 1968	Unpublished Calif. Div. Mines and Geology Spec. Rept. 96
Emerald Mountain	Gladys P. Louke, 19__	Unpublished
Fremont Peak	Dibblee, 1968	Calif. Div. Mines and Geology Bull. 188
Hawes	Dibblee, 1960	U.S. Geol. Survey MF-226
Inyokern	Dibblee, 1959 von Huene, 1956	U.S. Geol. Survey Open File 59-31 (Circ. 428) UCLA - Ph. D. thesis
Kramer	Dibblee, 1960	U.S. Geol. Survey Bull. 1089-B
Little Lake	Dibblee, 1959	Unpublished
Manly Peak	G. I. Smith, 1968	Calif. Div. Mines and Geology Spec. Rept. 96
Mojave	Dibblee, 1959	U.S. Geol. Survey MF-219
Onyx	Miller and Webb, 1940	Calif. Jour. Mines and Geology, v. 36, no. 4
Opal Mountain	Dibblee, 1968	Calif. Div. Mines and Geology Bull. 188
Pilot Knob	G. I. Smith, 1968 Smith and Ketner, 1970	Calif. Div. Mines and Geology Spec. Rept. 96 U.S. Geol. Survey Prof. Paper 700-D
*Randsburg	[1]Hulin, 1925	Calif. Div. Mines and Geology Bull. 95
Ridgecrest	von Huene, 1956	UCLA - Ph.D. thesis
*Saltdale	Dibblee and Gay, 1952	Calif. Div. Mines and Geology Bull. 160
Searles Lake	G. I. Smith, 1962 (no map) G. I. Smith, 1964 G. I. Smith, 1968 G. I. Smith (Quaternary geology)	AAPG Bull., v. 46, no. 1 U.S. Geol. Survey Prof. Paper 457 Calif. Div. Mines and Geology Spec. Rept. 96 Unpublished
Trona	Smith and others, 1968 Smith and others (Quaternary geol.)	Calif. Div. Mines and Geology Spec. Rept. 96 Unpublished
*Tehachapi	Dibblee and Louke, 1970	U.S. Geol. Survey I-607

Quadrangle 30-minute series	Author	Publisher
*Barstow	Bowen, 1954	Calif. Div. Mines and Geology Bull. 165

* Topo - Discontinued

[1] Geology modified by Dibblee, 1956, G. I. Smith, 1964 (unpublished)

I - Miscellaneous geologic investigations maps

GP - Geophysical investigations maps

MF - Mineral investigations, field studies maps

6

GEOLOGIC FORMATIONS

Geologic formations of each time period (system) are grouped together on the geologic map accompanying this report, because each system is the host of a distinctive set of commodities (see Table 4 of this report and Table 2 of the Randsburg-Searles Lake report). Within each system some formations are more favorable than others for mineral deposits, depending on their composition, depth, temperature, fracturing, and--for syngenetic deposits--their age. In general, limestone, because it is chemically active, and brittle rocks, because they fracture readily and retain permeability, are more favorable for epigenetic deposits.

Rock types of the principal named formations and their type localities are shown in Table 5; the following more detailed summaries of their lithology is from the Lexicon of Geologic Names of the United States, U.S. Geol. Survey Bull. 896, 1200, and 1350.

Table 4.--Distribution of mineral commodities by host rock
El Paso West, Red Mountain North and South, and
northern Searles Valley area

	Qal	Ql	Qb	Tsv	Ti	Kp.	Ki	Psv	pЄm
Antimony							x		
*Asbestos								?	?
†Borates				x					
†Clay				x					
Copper					x		x	?	x
†Feldspar						x			
Gems		x		x					
*Geothermal energy	x								
†Gold	x				x		x	?	x
Iron							x		
†Lead					x		x	?	x
*Limestone								?	
Manganese								x	
Mercury					?			?	
Molybdenum							x	?	
*Oil and gas				?					
Perlite				x					
*Quartz						x			
†Roofing granules				x			x		
Sand and gravel	x								
†Silver				x				?	
Sodium-potassium		x							
Stone				x	x				
*Thorium				x			x		
Tungsten							x	x	?
Uranium				x					
Zinc							x	?	

†Major commodities
*No production

Table 5.-- Type localities and rock types of principal named formations
El Paso area, Kern County, California

Formation	Type locality - Reference					Rock type	Age
	Sec.	Twp.	Rge.	Base Meridian	USGS Bull. (nos.)		
Almond Mountain Volcanics	34	29 S.	42 E.	MDBM	1350	Andesite breccia and flows	U(?) Pliocene
Atolia Quartz Monzonite		30 S.	41 E.	MDBM	896	Variations: Granite, granodiorite, diorite batholith	Cretaceous(?)
Bedrock Spring Formation	5	29 S.	42 E.	MDBM	1350	Sandstone, conglomerate, siltstone, tuff	M(?) Pliocene
Black Mountain Basalt		28 S.	38 E.	MDBM	896	Basalt flows	Pleistocene
Bobtail Quartz Latite of Gem Hill Formation	6, 7	10 N.	12 W.	SBBM	_/	Felsite, porphyry - extrusive, intrusive	Oligocene-Miocene
Bopesta Formation (Cache Creek)		32 S.	34 E.	MDBM	896	Sandstone, conglomerate, siltstone, basalt	U. Miocene
Garlock Series		28,29 S.	39 E.	MDBM	1200	Shale, chert, limestone, metavolcanics	Paleozoic
Gem Hill Formation of Tropico Group	25,26, 35	10 N.	13 W.	SBBM	1200	Tuff, agglomerate	Oligocene-Miocene
Goler Formation		28 S.	39 E.	MDBM	1200	Sandstone, fanglomerate, clay	Eocene
Horned Toad Formation	27,34	32 S.	35 E.	MDBM	1200	Gypsiferous clay, sandstone, siltstone, basal granitic conglomerate	M. and Lower Pliocene
Johannesburg Gneiss (2 mi. n. of Johannesburg)		29 S.	41 E.	MDBM	896	Hornblende-plagioclase gneiss, limestone, quartzite	Older(?) Precambrian
Kinnick Formation		32 S.	34 E.	MDBM	896	Tuff, tuffaceous sandstone	M. Miocene
Lava Mountains Andesite	NW¼SW¼ 8	29 S.	42 E.	MDBM	1350	Flows, breccias, intrusives	Pliocene
Mesquite Schist		29 S.	39 E.	MDBM	1200	Schist-thin limestone lenses	Younger Precambrian
Opal Mountain Volcanics		32 S.	45 E.	MDBM	1350	Rhyolitic felsite-extrusive, intrusive	Oligocene-Miocene
Pelona Schist (iden. to Rand Schist)	Sierra Pelona, L.A. County				896	Mica schist	Younger Precambrian
Pickhandle Formation	13	10 N.	2 W.	SBBM	1200	Rhyolitic-granitic breccia, limestone, chert, tuff, tuff breccia	Lower Miocene(?)
Rand Schist		30 S.	40 E.	MDBM	896	Schist - thin quartzite beds	Younger(?) Precambrian
†Red Mountain andesite (see Lava Mountains)		30 S.	41 E.	MDBM	896	Flows, agglomerates, tuffs - extrusive, intrusive	Pliocene
Ricardo Formation (at Ricardo)		29 S.	37 E.	MDBM	896	Conglomerate, sandstone, siltstone, chert, tuff, andesite, basalt, limestone	L. Pliocene
†Rosamond series (iden. to Tropico Group)		9 N.	12 W.	SBBM	896	Clay, sandstone, conglomerate, basalt, latite	Miocene(?)-Pliocene
Saddleback Basalt of Tropico Group)		11 N.	7 W.	SBBM	1200	Basalt (flows?)	Oligocene-Miocene
Tropico Group	2	9 N.	13 W.	SBBM	1200	Tuff, sandstone, conglomerate, basalt, qtz. latite	Miocene
Waterman Gneiss		10 N.	2 W.	SBBM	1200	Quartz diorite gneiss, marble beds	Older(?) Precambrian
Witnet Formation (N. side Oil Canyon)		32 S.	34 E	MDBM	895	Conglomerate sandstone	Oligocene

_/Dibblee, 1967, Prof. Paper 522.

† Name no longer used

Almond Mountain Volcanics

Pliocene, upper: Southern California.

G. I. Smith, 1964, U.S. Geol. Survey Prof. Paper 457, p. 5 (fig. 2), 23—32, pls. 1, 2. Lower part of section includes tuff breccia, tuff, lapilli tuff, sandstone, and conglomerate, which grade upward into massive rubble breccia. These stratified rocks grade laterally into their intrusive equivalents, some of which are hydrothermally altered to propylite. Thickness commonly 500 to 900 feet. Much thinner 2 or 3 miles from volcanic centers. The volcanics are intruded into, or rest with angular unconformity on, middle Pliocene Bedrock Spring Formation (new) and older rocks. Intruded or unconformably overlain by Lava Mountains Andesite (new). Type section designated, but neither this nor any other one section is representative of formation over a large area. Formation includes rocks that were divided by Hulin (1925) between "Rosamond Formation" and "Red Mountain Andesite."

Type section: Exposed about one-third mile northwest of summit of Almond Mountain. Measured column (fig. 11) extends 1,700 feet S. 700° E. from sec. E34-c [NW¼NW¼ sec. 34, T. 29 S., R. 42 E.] Named for Almond Mountain in southern part of Lava Mountains, San Bernardino County.

Atolia quartz monzonite.

Jurassic (?): Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (Calif. State Min. Bur. Bull. 95, pp. 33–42, map). Intrudes Rand schist and the undiff. Paleozoic series of El Paso Mtns, which may be in part Carbf. Uncon. underlies middle Mio. sediments (Rosamond series). Is undoubted correlative of plutonic rocks of Sierra Nevada and is probably of late Jurassic age. Named for exposures at and around Atolia, San Bernardino Co.

Bedrock Spring Formation

Pliocene, middle: Southern California.

G. I. Smith, 1964, U.S. Geol. Survey Prof. Paper 457, p. 5 (fig. 2), 10, 15—23, pls. 1, 2. Consists chiefly of coarse arkosic conglomerate, sandstone, siltstone, and claystone, with smaller amounts of limestone, evaporites, tuff, tuff breccias, rubble breccia, and lapilli breccia. Thickness more than 5,000 feet at type section. In some areas unconformably underlies conglomerate facies of Christmas Canyon Formation (new). Unconformably underlies Almond Mountain Volcanics (new). Unconformably overlies pre-middle Pliocene arkosic sandstones, conglomerates, altered volcanics, and unaltered volcanics. Assigned to middle Pliocene.

Vertebrate fossils indicate it to be of this age or possibly late early Pliocene. Rocks assigned to the Bedrock Spring were included in Rosamond Formation of Hulin (1925). That name not used in present report because Rosamond as mapped by Hulin included Bedrock Spring plus part of Almond Mountain Volcanics.

Type section (fig. 6, p. 16): Base located in sec. E5-f; from there extends N. 35° W. for 2,500 feet to base of unit 4; then is offset northeast to sec. B31-a, and from there extends N. 35° W. for 3,000 feet and then S. 80° W. for 6,500 feet [SE¼NW¼ sec. 5, T. 29 S., R. 42 E.] Named after Bedrock Spring, 2 miles north of Dome Mountain and about 1 mile west of type section, in Lava Mountains, San Bernardino County.

Black Mountain basalt flow.

Tertiary or Quaternary: Southern California (western El Paso Range, eastern Kern County).

C. L. Baker, 1912 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 7, pp. 121–142). *Black Mtn basalt flow.*—Olivine basalt, both vesicular and compact. Thickness more than 100 ft. Of post-Miocene Tert. age, and younger than Rosamond series.

C. D. Hulin, 1925 (Calif. State Min. Bur. Bull. 95, pp. 20–61). *Black Mtn basalt* is both intrusive and extrusive. Intrudes Rosamond series and Red Mtn andesite. Named for widespread basalt flows on Black Mtn, 7 mi. W. of El Paso Peaks, Kern Co., where they uncon. overlie Tert. sediments. They are probably very late Plio. or early Pleist.

Table 5.

BOBTAIL QUARTZ LATITE MEMBER

Member consists of felsitic and porphyritic volcanic rocks of quartz latite or rhyolitic composition occurring as plugs, pods, and dikes intruded through pre-Tertiary granitic rocks into stratified pyroclastic rocks of Gem Hill Formation and as short lenses of flow breccia within that formation in vicinities of Rosamond Hills, Middle Buttes, Soledad Mountain, and eastward to Bissell Hills (pl. 1); named after Bobtail mines, Soledad Mountain (Dibblee, 1958a, p. 140–141; 1963, p. 178–184); type locality, Soledad Mountain (secs. 6 and 7, T. 10 N., R. 12 W.).

Four facies of Bobtail Quartz Latite Member recognized and mapped (figs. 39–42) as follows: porphyry, felsite and porphyritic felsite, and perlite, all of intrusive origin, and felsite breccia, of probable extrusive origin.

Bopesta formation.

Miocene (upper): Southern California (northeastern part of Kern County).

J. P. Buwalda, 1934 (Pan-Am. Geol., vol. 61, No. 4, p. 310). *Bopesta fm.*—Wholly different from underlying Kinnick and Witnet fms., being continental in origin. Many hundred ft. thick in type section along Cache Creek, NE. of Monolith [NE. part of Kern Co.]. Contains the upper Mio. Cache Peak fauna. Moderately folded. Rests (probably uncon.) on Kinnick fm. [Derivation of name not stated.]

Garlock Series

Permian: Southern California.

T. W. Dibblee, Jr., 1952, California Div. Mines Bull. 160, p. 12 (fig. 1), 15-19, pls. 1, 2, 3. Thick series of slightly metamorphosed Paleozoic sediments and volcanics, in part if not all of Permian age. About 22,000 feet of section exposed; possibility of repetition by isoclinal folding within the section, or even by strike faulting, should not be overlooked. Occurs as a large inclusion within a granitic batholith. Shown on columnar section as underlying unnamed quartzite conglomerate and hornfels below newly defined Goler formation and overlying newly named Mesquite schist.

Crops out in northeastern part of El Paso Mountains, Saltdale quadrangle, Kern County. Exposed continuously from Mesquite Canyon northeastward, striking about N. 20° W., across mountains and dipping steeply to the northwest.

Gem Hill Formation (in Tropico Group)

Miocene(?): Southern California.

T. W. Dibblee, Jr., 1958, Am. Assoc. Petroleum Geologists Bull., v. 42, no. 1, p. 138 (fig. 2), 140. Name applied to lower unit of group in Rosamond district. Consists mainly of stratified light-colored rhyolitic lithic tuff, tuff-breccia, tuffaceous sandstone, volcanic agglomerate, and some conglomerates of both volcanic and granitic clasts; locally, thin basalt flows at or near the top. Thickness at Gem Hill 1,250 feet; at Antelope Buttes about 1,200 feet; thinner elsewhere. Overlies quartz monzonite; underlies Fiss fanglomerate (new), contact gradational at Gem Hill and sharp, locally unconformable contact elsewhere. In Soledad Mountains, includes Bobtail quartz latite member (new) at base.

Type locality: Gem Hill, in S½ sec. 25, SE¼ sec. 26, and NE¼ sec. 35, T. 10 N., R. 13 W., San Bernardino Base and Meridian, 5½ miles northwest of Rosamond, Rosamond quadrangle, Kern County. Exposed nearly continuously from Gem Hill southeastward 7 miles to Red Hill; other exposures at Little Buttes, Middle Buttes, Soledad Mountain, and ridge north of Bissell.

Goler Formation

Eocene to Miocene, lower: Southern California.

T. W. Dibblee, Jr., 1952, California Div. Mines Bull. 160, p. 12 (fig. 1), 19–25, pls. 1, 2, 3. Consists of some 6,500 feet of terrestrial conglomerate, sandstone, and clay. Comprises two unnamed members. Unconformably underlies Ricardo formation; unconformably overlies basement rocks; southwest from type section the Goler is overlapped by the Ricardo. Age shown on columnar section as Eocene-Oligocene-Miocene.

M. C. McKenna, 1955, Am. Assoc. Petroleum Geologists Bull., v. 39, no. 4, p. 512–515. Paleontological evidence indicates that most and probably all of formation is at least as old as early Tertiary.

Type section: Exposed in drainage area of Goler Gulch and northwestward to east slope of Black Hills, Saltdale quadrangle, Kern County.

Horned Toad Formation

Pliocene, lower and middle: Southern California.

T. W. Dibblee, Jr., 1958, Am. Assoc. Petroleum Geologists Bull., v. 42, no. 1, p. 137 (fig. 1), 138 (fig. 2), 143. Name applied to sequence of stream-laid and lacustrine sediments. Composed of upper member of gray gypsiferous clay, middle member of indurated green muddy sandstone with several layers of white caliche, and lower member of gray-white arkosic sands and interbedded light-reddish sandy siltstone with a basal granitic conglomerate. Formation moderately deformed. Thickness 1,055 feet. Mammalian fossils indicate early or middle Pliocene age. Overlies quartz monzonite of pre-Tertiary age and intrusive quartz latite of Tertiary age; unconformably underlies light-reddish sand, siltstone, and fanglomerate of probable Plestocene age.

Type locality: Horned Toad Hills, 4 miles northwest of Mojave, Mojave quadrangle, Kern County. Crops out from Warren Station, southwestward about 3 miles.

Johannesburg gneiss.

Pre-Cambrian: Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (Calif. State Min. Bur. Bull. 95, pp. 21–23, 28, map). *Johannesburg gneiss.*—Consists of a variety of rock types, the majority of them gneisses. In no case do they show true schistose cleavage. The most characteristic type represented may be termed hornblende-plagioclase gneiss; it shows a fine parallel banding of light and dark constituents. Another type, consisting entirely of coarsely crystalline black hornblende, may be termed hornblende gneiss. Interbedded with these varying types of gneisses there occur rather important quantities of massive and quite coarsely crystalline white marble in beds 1 to 20 ft. thick. In places thin layers of light-colored gneiss are intercalated with the ls. A subordinate amount of qtzite, which may be massive or coarsely banded, is interbedded with the marble and the gneisses. The fm. is predominantly if not entirely of sed. origin, and probably marine. The hornblende gneisses, however, may be derived from igneous rocks. A thickness of approx. 2,500 ft. outcrops, but neither top nor bottom was seen. Believed to uncon. underlie Rand schist. Assigned to Archean. Named for exposures 2 mi. N. of Johannesburg, Kern Co.

Kinnick formation.

Miocene (lower): Southern California (northeastern part of Kern County).

J. P. Buwalda, 1934 (Pan-Am. Geol., vol. 61, No. 4, p. 310). *Kinnick fm.*—Mainly basic volcanics, several hundred ft. thick, containing, in interbedded sediments, the Lower Mio. Phillips ranch mammalian fauna. Strongly deformed. Occurs NE. of Monolith [NE. part of Kern Co.]. Underlies (probably uncon.) Bopesta fm. and rests on Witnet fm. with strong angular uncon. [Derivation of name not stated.]

Lava Mountains Andesite

Pliocene, upper: Southern California.

G. I. Smith, 1964, U.S. Geol. Survey Prof. Paper 457, p. 5 (fig. 2), 32–40, pls. 1, 2. Consists of porphyritic plagioclase andesite. Occurs in tabular flows, 200 to 600 feet thick, and as mounds and domes formed above areas of upwelling lava. Typically forms caps of rolling or flat-topped hills, cropping out to form soft or boulder-strewn areas on the top and blocky cliffs along the edges. Unconformably overlies Almond Mountain Volcanics (new) and older rocks (Bedrock Spring Formation, new). Overlain by a few patches of gravel. Fine Quaternary rock units are inferred to be younger on basis of indirect evidence. Probably very late Pliocene but may be in part Pleistocene. Formation is approximately equivalent to Hulin's (1925) "Red Mountain Andesite."

Type locality: On southeast side of Dome Mountain, in sec. E8—m [NW¼SW¼ sec. 8, T. 29 S., R. 42 E.]. In Lava Mountains, San Bernardino County.

Mesquite Schist

Precambrian (?) : Southern California.

T. W. Dibblee, Jr., 1952, California Div. Mines Bull. 160, p. 12 (fig. 1), 14–15, pls. 1-3. Chlorite-quartiz-albite-sericite schist; dark steel gray when fresh, weathers to light silvery gray; prominently and thinly bedded; uppermost 500 feet contains many interbeds of fine crystalline limestone, some as much as 10 feet thick. Total thickness about 4,500 feet. Schist dips east under Garlock series (new) ; contact sharp, concordant; probably a disconformity. Columnar section shows Mesquite schist younger than Rand schist.

Exposed in Mesquite Canyon in El Paso Mountains, Saltdale quadrangle, Kern County.

Opal Mountain Volcanic Formation

Oligocene(?) to Miocene, middle: Southeastern California.

T. W. Dibblee, Jr., 1967, U.S. Geol. Survey Prof. Paper 522, p. 86, pls. Volcanic rocks of rhyolite and quartz latite composition occurring as intrusive plugs and extrusive flow breccias in pyroclastic rocks of Pickhandle Formation. Volcanic rocks emplaced during time of deposition of Pickhandle Formation are therefore the same age as the Pickhandle.

Type locality: In vicinity of Opal Mountain and forks of Black Canyon to northwest. Mohave Desert, San Bernardino County.

Pelona schist.

Pre-Cambrian (?) : Southern California (Los Angeles County).

O. H. Hershey, April 1902 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 3, pl. 1, map). [*Pelona schists* on legend of map lie btw. gneiss below and Archean gneiss above.]

O. H. Hershey, 1902 (Am. Geol., vol. 29, pp. 273–290). *Pelona schist series.*—Three thousand ft. of dark-colored and more schistose mica schist underlain by 2,000 ft. of light-yellowish course angular mica schist. Assigned to pre-Camb. (?). Named for Sierra Pelona, Los Angeles Co.

O. H. Hershey, 1912 (Am. Jour. Sci., 4th, vol. 34, pp. 271–273). Another area of *Pelona series* constitutes greater part of Rand Mtns near Randsburg, Kern Co. This series is youngest important Archean series. I propose to extend the name over Abrams and Salmon fms. of Klamath region.

E. C. Simpson, 1934 (Calif. Jour. Mines and Geol., vol. 30, No. 4). *Pelona schist series*, 7,500+ ft. thick in Elizabeth Lake quad., is probably Archean. Identical in lithology and structure with Rand schist of Randsburg quad.

Pickhandle Formation

Miocene, middle: Southern California.

O. E. Bowen, Jr., 1954, California Div. Mines Bull. 165, p. 138. Mentioned in discussion of silver-barite veins at Waterman mine, Calico district. Principal vein roughly follows bedding of a sequence of dacitic tuffs, lakebed clays and siltstones, and granitic fanglomerate probably belonging to Pickhandle formation; jasper appears bedded and may have been an original member of Pickhandle. Name credited to Thane McCulloh (unpub. rept.).

Waterman mine is in NE¼ sec. 13, T. 10 N., R. 2 W., 4 miles north of Barstow, via Camp Irwin Road, Barstow quadrangle, San Bernardino County.

Rand schist.

Pre-Cambrian: Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (Calif. State Min. Bur. Bull. 95, pp. 23–29, map). *Rand schist.*—Predominately mica-albite schist, showing highly developed schistosity; usually dark silvery gray, but weathers yellowish brown. Amphibole schists are next in order of abundance, and are only slightly subordinate in amount to the mica albite schist. Actinolite schist, actinolite-talc schist, talc schist, and hornblende schist also occur in minor amounts. The mica-albite schist and the amphibole schists are interbedded with qtzite and ls. in beds from 1 to 10 ft. thick. Greenstone schist, of igneous origin, is present in small, irregular, and isolated masses. Rest of fm. is of sed. origin. Is believed to uncon. overlie Johannesburg gneiss and to uncon. underlie the rocks of Paleozoic age. Assigned to Archean. Thickness exposed is probably btw. 1,500 and 2,000 ft. Composes bulk of Rand Mtns, Kern Co.

Red Mountain andesite.

Miocene (upper): Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (Calif. State Min. Bur. Bull. 95, pp. 55–58, map). *Red Mountain andesite.*—Chiefly lava flows, but with prominent amounts of aggls. and tuffs. General composition of series is that of basic andesite. Overlies Rosamond series, usually with angular uncon., and uncon. underlies Black Mountain basalt. Forms thick capping of Rosamond series in Red Mtn [San Bernardino Co.], where it reaches approx. thickness of 1,400 ft. of flows and pyroclastics. Believed to be early Plio. [On map is assigned to upper Mio.]

Ricardo formation.

Pliocene (lower): Southern California (Kern and San Bernardino Counties).

J. C. Merriam, 1914 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 8, pp. 276, 278). The *Ricardo Plio.* is next faunal stage known after the Mohave in the Great Basin. A series of beds, occurring at Ricardo [Kern Co.], on W. border of Great Basin, representing a faunal and strat. stage which is distinctly pre-Pleist., is certainly much later than the Mohave Upper Mio., and presumably represents early Plio. Doubtful that much, if any, of the Plio. of King really represents the *Ricardo stage.*

J. C. Merriam, 1915 (Pop. Sci. Monthly, vol. 86, pp. 252–254). The *Ricardo beds* contain Plio. mammals.

J. C. Merriam, 1917 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 10, pp. 430–443). *Ricardo fm.*—Thickness 3,000 to 5,000 ft. Contains Plio. fauna. The beds in which the fauna occurs consist in large part of tuffs with desert cgls. or fangls. and other deposits formed on land or in evanescent water bodies. Fauna seems to be a unit not divisible into sharply separated stages and indicates an earlier stage than Thousand Creek and Rattlesnake, which is supported by greater degree of induration and deformation of the Ricardo. Is younger than Barstow fm.

J. C. Merriam, 1919. (See under †*Red Rock Canyon beds.*)

†Red Rock Canyon beds.

Pliocene (lower): Southern California (eastern part of Kern County).

J. C. Merriam, 1919 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 11, No. 5). There may be some justification for name *Red Rock Canyon beds, fm., or group,* for strat. sequence containing Ricardo fauna, but G. K. Gilbert (Geog. and Geol. Expl. W. 100th Mer., pp. 142–143, 1875) and H. W. Fairbanks (Am. Geol., vol. 17, pp. 68-69, 1896) did not use the name for nomenclature purposes. Following the discovery that the fauna from the beds in Red Rock Canyon [at Ricardo, E. part of Kern Co.] is sharply distinct from that in Barstow section, writer has described numerous mammalian forms from Red Rock Canyon section as representing the *Ricardo fauna, Ricardo beds,* or *Ricardo Pliocene,* and he therefore prefers the name *Ricardo fm.* or *Ricardo group* for the deposits containing them.

†Rosamond series.

Tertiary (Miocene?): Southeastern California (southeastern Kern County and northern Los Angeles County).

O. H. Hershey, April, 1902 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 3, pl. 1, map). [On legend of map *Rosamond series* appears btw. Cret. shales below and Escondido series above, and is mapped to N. of Rosamond, Kern Co.]

O. H. Hershey, 1902 (Am. Geol., vol. 29, pp. 349–372). *Rosamond series.*—A rhyolite series, 1,650 ft. thick, consisting of interbedded ss. and rhyolite tuff with one massive bed of dark-red lava. Uncon. underlies Barstow series. Type section near Rosamond Station.

J. C. Merriam, 1919 (Calif. Univ. Pub., Dept. Geol. Bull., vol. 11, No. 5, pp. 440–448). While the name *Rosamond series* may tentatively be used for middle and late Tert. sediments of Mohave area, it has not been demonstrated that the several fms. represented are as closely related in their depositional history as they appeared in first investigations. If Barstow fm. is a memb. of Rosamond series of Hershey it is a late memb. It will be recognized as a div. of Rosamond series. It is doubtful if Rosamond series comprises sediments of the stage represented at Ricardo.

C. D. Hulin, 1925 (Calif. State Min. Bur. Bull. 95), assigned *Rosamond series* to upper Mio.

E. C. Simpson, 1934 (Calif. Dept. Nat. Res., Div. Mines, Calif. Jour. Mines and Geol., vol. 30, No. 4, p. 400). Only fossils found in *Rosamond fm.* of Elizabeth Lake quad. are reeds, calc. algae, and fragments of silicified wood, all rather useless in correlation. But abundant mammalian remains have been found in upper members of Rosamond fm. at Barstow and determined by J. C. Merriam (1919) to be upper Mio. This age may be accepted as not far wrong for the Rosamond of Elizabeth Lake quad.

C. D. Hulin, 1934 (p. 420 of book cited above under *E. C. Simpson*). Age of middle and upper phases of *Rosamond series* can be fixed as early Upper Mio. on basis of vertebrate fossils in Barstow syncline; and it appears probable base of the Rosamond is not older than Middle Mio., but this needs verification.

Saddleback Basalt (in Tropico Group)

Saddleback Basalt (in Ricardo Formation)

Pliocene(?): Southern California.

H. S. Gale, 1946, California Jour. Mines and Geology, v. 42, no. 4, p. 326, 339, 346–350. Name applied to basaltic lavas which form base on which borate-bearing lake beds (Kramer Lake beds) rest. They rise in dip slope outcrops around northern borders of basin where borates occur. Flows vary in thickness from 600 feet maximum to where they pinch out and disappear in an area along the southern border of the basin. Present in Ricardo formation only in Kramer borate district.

T. W. Dibblee, Jr., 1958, Am. Assoc. Petroleum Geologists Bull., v. 42, no. 1, p. 137 (fig. 1), 138 (fig. 2), 142. Redefined as local formation in Tropico group (new). At type section, rests on quartz monzonite but elsewhere rests with probable slight unconformity on lower part of Tropico group. In Kramer borate district, these underlying rocks were referred to as Rosamond formation by Gale (1946). The Saddleback is overlain unconformably by the borate-bearing shale of upper part of Tropico in Kramer district in the borate mines and unconformably by fanglomerate of probable Pleistocene age at the surface. Pliocene(?). Type locality designated.

Type locality: Saddleback Mountain in S¼ sec. 9, T. 11 N., R. 7 W., 4 miles north of Boron, Boron quadrangle, San Bernardino County. From Saddleback Mountain, basalt crops out as scattered exposures in low isolated hills toward northwest for 6 miles, and west about 10 miles.

Tropico Group

Miocene(?) and Pliocene(?): Southern California.

T. W. Dibblee, Jr., 1958, Am. Assoc. Petroleum Geologists Bull., v. 42, no. 1, p. 135-139. Name applied to sequence of nonmarine sedimentary, pyroclastic, and volcanic rocks exposed in Rosamond Hills and originally described as Rosamond series by Hershey (1902), together with similar and probable correlative rocks of Tertiary age exposed in vicinities of Kramer borate area and in Kramer Hills in western Mojave Desert. Rocks of group are moderately deformed and rest on deeply eroded surface of pre-Tertiary granitic and metamorphic rocks that form crystalline basement complex of region, and are overlain unconformably by Quaternary alluvial sediments. Maximum exposed thickness about 2,800 feet. Group is divided into several lithologic units of local extent. In most sections lower unit is pyroclastic formation, with associated rhyolitic intrusions and flow breccias; upper unit is either fanglomerate or sequence of carbonate rocks, clays, and sandstones of lacustrine and fluviatile origin; basalt flows occur locally, mostly in middle part. Group is nonfossiliferous except at one locality where diatom remains in upper part suggest early Pliocene age. Lower unit is tentatively correlated with lithologically similar formations of known Miocene age in areas west and northwest. Formations that are locally distinct are: Gem Hill formation, Fiss fanglomerate, Bissel formation, Saddleback basalt, and Red Buttes quartz basalt.

Type section: In Rosamond Hills one-half mile west of Mojave-Tropico Road 1 to 2 miles north of Tropico mines, Rosamond quadrangle, in NE¼ sec. 2, T. 9 N., R. 13 W., San Bernardino Base and Meridian, Kern County. Most complete sections are at Antelope Buttes, Rosamond Hills, hills north of Bissell, at and near Castle Butte, and in Kramer Hills; incomplete sections are at Soledad Mountain and Kramer borate area.

Waterman Gneiss

Precambrian(?) or Upper Paleozoic(?): Southern California.

O. E. Bowen, Jr., 1954, California Div. Mines Bull. 165, p. 16 (fig. 2), 17-23, pls. 1, 2, 3. Black hornblende-plagioclase-quartz-mica gneiss and local diorite and pegmatite. At least 4,000 feet thick at type section. Believed to be younger than Oro Grande series and intrusive into it.

T. W. Dibblee, Jr., 1960, U.S. Geol. Survey Mineral Inv. Field Studies Map MF-233. Probably Precambrian, possibly Paleozoic. In vicinity of Hinckley Mound, was mapped by Bowen as Oro Grande series and gneissic hornblende diorite. Maximum exposed thickness about 10,000 feet.

Type section: In deeply eroded northeast-trending broad simple anticline south of Camp Irwin Road opposite Waterman silver mine, Barstow quadrangle, San Bernardino County. Unit covers about 3½ square miles in Barstow quadrangle and extends east into unmapped territory for undetermined distance.

Witnet formation.

Tertiary (pre-Miocene): Southern California (northeastern part of Kern County).

J. P. Buwalda, 1934 (Pan-Am. Geol., vol. 61, No. 4, p. 310). *Witnet fm.*—Many hundred ft. of arkosic cgl. and coarse ss., overturned and overthrust by pre-Cretacic crystalline rocks from the SE. Is pre-Mio. Tert. Occurs NE. of Monolith [NE. part of Kern Co.]. At type section, along N. side of lower Oil Canyon, overlain with strong angular uncon. by Kinnick fm. (Lower Mio.). [Derivation of name not stated.]

(p. 18 follows)

El Paso West area
Kern County, California
Location - see Introduction

The following inventories include all the mineral deposits listed in County Report 1 (Troxel and Morton, 1962). They are grouped by commodity in alphabetical order, except for the first group of four mines which are shown on the topographic maps but are either unlisted or are listed in a different section in the township.

COMMODITY UNKNOWN

Name	Location on map (MDBM)			Quadrangle
	Sec.	Twp. S.	Rge. E.	
Amalia (see Sb)	6	31	36	Cross Mountain
Don Levy	14	29	34	Emerald Mountain
Miller	4	31	36	Cross Mountain
Mohawk Buddy	SE34	29	36	Cross Mountain

ANTIMONY

The total value of antimony produced in Kern County is about $80,000--about a third of the value of all the antimony produced in the state. Productive periods were during times when antimony prices were high--1915-17, 1925, 1928, 1939-42, 1952-53, and 1958. The largest producer was the San Emigdio (Antimony Peak) mine in T. 9 N., R. 21 W., SBBM.

In the El Paso area, several shipments were made from the Amalia mine on Antimony Flat; production from the nearby Antimony Consolidated mine was not determined.

Name	Location (MDBM)			Production
	Sec.	Twp. S.	Rge. E.	
Amalia (Cowboy No. 1?)	5, 8	31	36	1917-18, 1940
Antimony Consolidated	5	31	36	

The ore bodies at these mines are stibnite-bearing quartz veins in granodiorite. At the Antimony Consolidated mine, two parallel veins about 400 feet apart strike N. 30° W., and dip 70° NE. The southwest vein is exposed in shafts and trenches for 600 feet along the strike. Stopes are indicated by subsiding ground near the shafts. The northeast vein is exposed for a few tens of feet in a shaft and three trenches.

ASBESTOS

There has been no production of asbestos from Kern County, although three deposits have been reported. One of these, the Sunshine, is in the El Paso area.

The three Sunshine claims were located in 1912 in sec. 7, T. 30 S., R. 36 E. MDBM. Subsequent activity, if any, has not been reported. Asbestos-bearing rock reported to be 10 feet wide and 150 feet long strikes northeast and dips 40° S. between serpentine walls.

BORATES

The Boron mine (Table 6) 4 miles northwest of Boron, Kern County, is the largest producer of borax in the United States. It is an open pit located on the Kramer sodium borate ore body, parts of which were formerly mined by underground methods. It contains reserves for about 100 years at present rates of production. Smaller and lower grade deposits of calcium borate have been found in the shale beds peripheral to the Kramer deposit, and in similar shale in nearby localities. Two of these, the East Kramer deposits, are considered to be resources for the future as they are not now competitive with sodium borate which requires little beneficiation.

The Kramer ore body is a slightly warped and faulted lake bed deposit in the upper part of the Tropico group of formations of Miocene age. The "Kramer" lake beds, which overlie the Saddleback Basalt flows, consist of three parts, a dark-gray "footwall" shale 25-30 feet thick, a middle blue shale 200-250 feet thick and 1 x 4 miles in area, and a hanging-wall green shale 30-50 feet thick. The hanging-wall shale is overlain by sandstone about 80 feet thick which grades upward into fanglomerate about 500 feet thick. The footwall shale contains nodules and veinlets of ulexite and howlite, the middle shale above ~~and~~ peripheral to the ore body contains disseminated ulexite and colemanite, and the hanging-wall shale contains a few lenses of nodular colemanite. The ore body occupies the central part of the middle shale in an area half a mile wide, 2 miles long, and as much as 200 feet thick at depths of 137-1,000 feet below the surface. It consists of layers of crystalline and nodular borax and--in the lower part--secondary kernite. A few lenses of shale are locally as much as 21 feet thick; they contain from less than 1 percent to nearly 100 percent borates. The ore body contains other borates, and sulfides of arsenic, antimony, and iron. The main ore body averages about 25 percent B_2O_3 (Gale, 1946; Dibblee, 1967). The peripheral zone of calcium borate in shale is of generally lower grade.

Exploratory drilling in 1955-1959 in the East Kramer area revealed two small low-grade deposits of calcium borate, mostly colemanite, at depths of 780 feet and 458 feet in a shale bed similar to that of the large Kramer ore body. The deeper deposit called the East Kramer section 30 deposit is as much as 100 feet thick, covers about 200 acres (secs. 29, 30, 31, 32, T. 11 N., R. 6 W.), and contains about 40 million tons that averages about 14 percent B_2O_3. The other deposit called the East Kramer section 13 deposit covers less than 100 acres (S½ sec. 13, T. 11 N., R. 7 W.) and is at least 98 feet thick, but the holes did not reach the bottom of the deposit. Average grade of the zone penetrated is about 3.7 percent B_2O_3 (Dibblee, 1967, p. 126).

Areas favorable for the discovery of still other deposits are illustrated by Dibblee (1967, p. 113) and classified as follows:

1. Kramer basin: - most favorable
2. Fremont basin: - probably unfavorable
3. Barstow basin: - favorable
4. Valley of Cuddeback Lake: - probably unfavorable
5. Koehn basin: - northwest of lake, possibly favorable
   - southwest of lake, probably unfavorable
6. Ricardo basin: - favorable
7. Tehachapi basin: - unfavorable
8. Mojave basin: - probably unfavorable
9. West Antelope basin: - probably unfavorable
10. East Antelope basin: - unfavorable
11. Cajon basin: - unfavorable

Table 6.--Borax mines.

El Paso (Boron) area, Kern County, California

Commodity - Borates

Name of mine[1]	Location				Production
	Sec.	Twp.	Rge.	B&M	
Baker	19	11 N.	7 W.	SB	1927-1950's
Balling I	24	11 N.	9 W.	SB	None
Balling II	18	11 N.	7 W.	SB	None
Marshall Bond	19	11 N.	8 W.	SB	None
Boron pit	23	11 N.	8 W.	SB	1957- present
Stuart Chevalier	35	31 S.	40 E.	MD	None
East Kramer Sec. 30	29,30, 31,32	11 N.	6 W.	SB	None
East Kramer Sec. 13	S½ 13	11 N.	7 W.	SB	None
Jenifer	23	11 N.	8 W.	SB	1951-57
Kohler	20	11 N.	8 W.	SB	None
Leopold	24	11 N.	9 W.	SB	None
McGinty	1,12,8	11 N.	8,7 W.	SB	None
Mudd (Western, Little Placer)	24	11 N.	8 W.	SB	1927-57
Pacific Alkali Co.	18	11 N.	7 W.	SB	None
Russell I	21	11 N.	8 W.	SB	
Russell II	18	11 N.	7 W.	SB	
Slosser	22	11 N.	8 W.	SB	
Sukow colemanite	22	11 N.	8 W.	SB	Small
Suckow discovery well	22	11 N.	8 W.	SB	
West Baker (Suckow)	14	11 N.	8 W.	SB	1929-57

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[1] See Dibblee, 1967, fig. 46

Abstract--History of borax production in the United States (after Ver Planck, 1956)

Lake County period (1864-72)

Borax was first produced in the United States in 1864 when borax crystals were recovered by washing them from the muds of Borax Lake in Lake County, Calif. This operation ended in 1872 owing to depletion and to flooding of the lake by an artesian well.

Playa period (1872-90)

Ulexite was discovered in 1870 or 1871 in the surface crusts of playas, first near Sand Springs, Churchill County, Nev., and later in Columbus Marsh, Esmeralda County, Nev.; small scale operations resulted. In 1872, the playa crust of Teels Marsh, Mineral County, Nev., was found to be rich in borax; other discoveries in Nevada and southeastern California soon followed. Hundreds of producers were operating during the 1870's, but in California activity was confined largely to Koehn Lake (1873), Searles Lake (1874), and Salt Wells Valley (1874). Only a few of the many ventures were financially successful and most were closed by 1880 when the borate-bearing playas at the mouth of Furnace Creek in Death Valley were discovered. Borax from these and other playa deposits was transported to Mojave in the now famous 20-mule-team wagons until 1898. The playa crust deposits were gradually supplanted as a source of borax by the discoveries of colemanite deposits near Furnace Creek in 1882, at Borate near Calico in 1883, and in the Frazier Mountain district (Ventura County) in 1898. The last of the playa operations were one in Saline Valley, which produced borax through 1907, and a few leaseholds in Nevada which were operated until about 1908.

Colemanite period (1890-1907)

Colemanite mined by underground methods was obtained mainly from the deposits at Borate, where production started in 1890. At first, the ore was hauled from Borate to Daggett with two of the 20-mule-team wagons that had been used in Death Valley, and shipped by rail to Alameda, Calif. Later, in 1898, a plant was built at Marion, 4 miles from Daggett, and a rail spur was laid to the mines at Borate. These mines operated until 1907.

Death Valley period (1907-1927)

Meanwhile, other deposits of colemanite were found. Development of the largest, the Lila C. mine in Death Valley, began in 1903, but transportation with traction engines proved unsatisfactory and the owner, Pacific Coast Borax Company, built the Tonopah and Tidewater Railroad from which a spur line reached the mine in 1907. In that same year a large deposit of higher grade colemanite was found in Tick Canyon in Los Angeles County; it yielded a substantial share of the total production from 1908 to 1920, and was operated until 1923. The Lila C. mine was replaced by deposits at new Ryan, western terminal of the Death Valley Railroad, in 1915. Commercial production of borax as a by-product of potash from the brines of Searles Lake began in 1919. Another colemanite deposit, one of the last to be discovered, was found near Shoshone, Inyo County; the Gerstley mine began production in 1924.

Kramer period (1927-present)

All of the colemanite mines were rendered submarginal, however, by the discovery in 1925 of the 80-million-ton borax deposit at Kramer. Production from the Kramer deposit began in 1927 at the Baker mine, in 1929 at the West Baker (Suckow) mine, and in 1951 at the Jennifer mine, but since 1957, production has been solely from the Boron open-pit.

Total U.S. output of boron compounds in 1971, more than a million tons, came from four California producers: United States Borax and Chemical Corp. at Boron, Kern County; Kerr-McGee Chemical Corp. and Stauffer Chemical Co. both at Searles Lake, San Bernardino County; and Tenneco, Inc. near Ryan, Inyo County. Open-pit mining by Tenneco began in 1971 from a colemanite deposit 25-30 feet thick after stripping 150 feet of overburden. The colemanite is used in the manufacture of glass fiber, not as a source of refined borax.

CLAY

The following deposits are in the El Paso West area:

Name	Location				Production (tons)
	Sec.	Twp.	Rge.	Base Meridian	
Amargo (Vanuray claim)	26	11 N.	8 W.	SB	> 6,000
Muroc (Badger)	2, 3	11 N.	9 W.	SB	40,000
White Rock (Jawbone Canyon, White Point, Williams)	34	30 S.	35 E.	MD	>50,000
White Swan	NE¼ 14	30 S.	36 E.	MD	
Unnamed No. 2.	34	32 S.	35 E.	MD	

Amargo bentonite deposit. The deposit is a sedimentary layer about 20 feet thick of unknown areal extent interbedded in shales of the Tropico Group of Miocene age. The bentonite swells slightly in water. It contains minor amounts of carnotite, opal, and iron and manganese oxide coatings on shear planes. Because the deposit is poorly exposed its full extent cannot be estimated, but where the soil cover is thin to the south of the workings, several thousand tons were indicated in 1958.

Muroc clay deposit. The clay occurs as a single layer 6 feet thick exposed for 400 yards along the strike interbedded in lake sediments which in the Castle Butte area 5 miles to the northwest are 1,445 feet thick and are capped by basalt. The lake sediments consist principally of lithic tuff, limestone, clay shale, and sandstone. All beds below the basalt are assigned to the lower part of the Tropico group of Miocene age. The clay bed is underlain by tuff and overlain by tuff and swelling bentonite, and about 10 feet of basalt. The clay is nonswelling, hard, and nearly pure white; it is naturally active and activatable and can be classed as fuller's earth. The deposit was considered by the owners in 1945 to be nearly depleted.

White Rock claystone deposit. The claystone is apparently an altered rhyolite dike or sill as much as 80 feet thick intruded into Tertiary sediments which overlie Mesozoic granodiorite. The deposit is irregularly shaped and is exposed over several acres. Completely altered material is largely kaolinite(?). Reserves were estimated in 1958 to be sufficient for many years at the existing rate of consumption--about 5,000 tons per year.

White Swan bentonite deposit. The deposit is a bed about 10 feet thick that crops out for several hundred yards intercalated in a series of pink, pale-green, and pale-gray tuffs. It strikes N. 40° E. and dips 49° NW. The bentonite contains interbedded platy bands.

Unnamed No. 2 bentonite deposit. The deposit is a bed 30 feet thick that strikes N. 55° E., dips 26° NW., and is exposed for 350 feet along the strike. It is underlain by green sandstone of the Horned Toad Formation of Pliocene age and overlain by pink sandstone of Pleistocene age. The clay is locally gypsiferous and swells slightly. The Horned Toad Formation crops out from Warren Station southwestward for 3 miles.

COPPER

Most of the 1,152,000 lbs of copper mined in Kern County during 1900-1957 came from the Woody district in Tps. 25 and 26 S., Rs. 29 and 30 E., MDBM. The most productive copper mine in the district and in the county is the Greenback which yielded about 600,000 lbs of copper from ore that averaged about 5 percent copper and 2 ounces of silver per ton. The mine has been inactive since 1918. Elsewhere in the county, some copper has been obtained as a by-product, mostly from widely distributed gold mines. None of the copper mines listed by Troxel and Morton is in El Paso West area, but three of the gold mines (Pride of Mojave, Standard, Yellow Dog) may have produced copper as a by-product.

GEMS

Petrified wood occurs in Quaternary lake beds, and "chaffonite" chalcedony in amygdaloidal basalt in the hills flanking Boron Dry Lakes in secs. 3, 4, and 14, T. 11 N., R. 9 W., SBBM.

GOLD

In Kern County, the number of gold deposits and the total value of gold mined exceed that of any other metal. Although most of the deposits are in the Sierra Nevada, almost half the total production--which exceeded $46 million--through 1957 came from two mines east of the Sierra. The Yellow Aster mine in the Rand district yielded $12 million (1895-1939), most of it at the pre-1934 price of $20.67 per ounce; the Golden Queen group in the Mojave district yielded more than $10 million (1894-1954), at prices of $20.67 and $35 per ounce.

Of the 44 gold deposits (Table 7) in the El Paso West area listed by Troxel and Morton (1962), all are quartz veins except the Kelso Creek placers which were derived from quartz veins, and the Little Audrey, Northern View, Prize, and Stardust No. 1 which are nonproductive prospects on iron-stained shear zones without quartz. All the quartz veins are in Cretaceous(?) quartz monzonite or related granitic rocks, although a few are also partly in or along Tertiary rhyolite dikes, diorite dikes, or rhyolite porphyry, except the Nadeau where the veins are in Precambrian schist and quartzite, and the Pride of Mojave where quartz lenses are in calcite veins in quartz monzonite.

The quartz veins pinch and swell along the strike and down the dip; they range in width from stringers an inch or so wide to a maximum of 20 feet at the Standard mine, but most of the veins are less than 4 feet wide. They range in length from a few feet to about a mile, but most of them are less than 500 feet long. The deepest workings are on the 900-foot level at the Standard mine.

The size of the ore shoots is not generally reported, but the most productive vein was in the Standard mine where the largest ore shoot in the Exposed Treasure vein averaged about 6 feet wide, extended 150 feet along the strike, and was stoped down the dip from the surface(?) to the 500-foot level. In the Yellow Dog mine, the largest ore shoot was mined 200 feet along the strike from the surface to a few feet below the 300-foot level.

The ore minerals are free gold, auriferous pyrite, argentiferous galena, chalcopyrite, and their oxidation products. Chlorargyrite is a principal ore mineral in the Exposed Treasure vein (Min. Rec., v. 6, No. 1, p. 42). The essential gangue mineral is quartz; calcite is apparently premineral, and shear zones without quartz may contain pyrite and a little chalcopyrite but virtually no gold. Other gangue minerals local include arsenopyrite, stibnite (St. John mine), and manganese oxide (Vera Queen mine).

Grade of the ores mined ranged from something less than profitable to small high-grade pockets. The Whitmore mine yielded 7,500 tons averaging 0.3 oz gold and 8 oz silver per ton; the Yellow Dog mine yielded more than 4,500 tons that averaged 1.3 oz gold and 8 oz silver per ton.

Table 7.--Gold deposits

El Paso West area, Kern County

[Blank spaces, information unavailable; *see text (Troxel and Morton, 1962]

Name	Location				Production	Host rock	Type deposit	Dimensions	Minerals
	Sec.	Twp.	Rge.	Base Meridian				wide x long x deep (feet)	
Bellflower (Huntington)	29	27 S.	40 E.	MD	Mill (1957)	q. m.	Q vein	0.1-4 x 200 x 100	Au, Fe, Cu
Burning Moscow	N½ 25 or 19	28 S. 28 S.	34 E. 35 E.(?)	MD MD	Minor Au, Cu	q.m.	Q vein	2-4 x x 150	Au,Cu,FeS$_2$
Eldorado	NE¼ 33	27 S.	40 E.	MD	Prospect	q.m., rhy. dike	Q vein	¼ x x 60	
Esperanza mine	5,6	29 S.	35 E.	MD	* >20 oz	granitic	Q vein	½-3 x 700 x 270	Au,FeS$_2$
*Gold Bug	NW¼ 34	27 S.	40 E.	MD	1890-1949 Several stopes	q. m.	Q veins	1½-8 x 500 x 300	Au, Ag, Cu
Gold Coin claim	NE¼ 31	11 N.	12 W.	SB	None				
Gold Pass	22, 26	27 S.	40 E.	MD	Minor	q.m., rhy. dikes	Q vein-silic. fault	1-2½ x 1,000 x 80	Au, FeO$_x$
Gold Peak mine	NE¼ 6	29 S.	36 E.	MD	(?)	granitic	Q vein	½-4 x 120 x 60(?)	Au, FeS$_2$
Granite King	NW¼ 33	29 S.	36 E.	MD	Mill (1934)	grd.	Q vein	x 60 x 60	Au
Gum Tree	E½ 32	11 N.	12 W.	SB	>40 oz		Q vein	4-6 x 500(?)x 200	Au, Ag
Haunita (Crown Consol.?)	NW¼ 26	27 S.	40 E.	MD	Minor(?)	grd.	Q vein	½-3 x 1,300 x	Au, FeO$_x$, Cu
Hoodoo	NW¼ 34	27 S.	40 E.	MD	None(?)	q. m.	Q vein	3/4 x 70 x 90	FeO$_x$, Cu
Horoscope (Lost Keys?)	SW¼ 28	27 S.	40 E.	MD		q. m.	Q vein	1/6-½ x x 100(?)	FeO$_x$
Hub	N½ 4	31 S.	35 E.	MD	5± oz	rhy	Q vein	2 x x	Au
Iriquois	26	27 S.	40 E.	MD	Prospect	grd.	Q vein	<1 x 100 x 20	FeO$_x$
Jerry mine	34 3	27 S. 28 S	40 E. 40 E.	MD MD	$12,000±	q. m.	Q veins	1/6-8 x 135 x 120	Au
Kelso Creek placers	16	28 S.	40 E.	MD	1932-33 50¢/cu yd	gravel	placer	150 x x 10-30	Au
Lehigh Valley	NW¼ 29	27 S.	40 E.	MD	Arrastre 1933	granitic	Q veins	½-6 x 40(?) x	Au, FeS$_2$
Little Audrey	S½ 28	27 S.	40 E.	MD	Prospect	di. dike	shear zone	x x 100	FeO$_x$
Lone Star prospect	27, 28	29 S.	36 E.	MD	Old mill	q. di	Q vein (stringer)	x x 70	Au
Lost Keys	27, 28	27 S.	40 E.	MD	$800±	grd.	Q vein	½-3 x. x 105	Au
Miles	SE¼ 4	31 S.	36 E.	MD	None(?)	rhy. grd.	Q vein		Au, FeS$_2$
Nadeau (Rankin)	NE¼ 11	26 S.	37 E.	MD	Small	sch., qtzite	Q vein	x 60(?) x 80	Au, FeS$_2$, FeAsS

Table 7 .--Gold deposits--Continued

El Paso West area, Kern County

[Blank spaces, information unavailable; *see text (Troxel and Morton, 1962)]

	Location				Production	Host rock	Type deposit	Dimensions	Minerals
	Sec.	Twp.	Rge.	Base Meridian				wide x long x deep (feet)	
Northern View	E½ 20	27 S.	40 E.	MD	Prospect	q. m..	shear zone		FeO_x
Pay Day	SW¼ 28	29 S.	36 E.	MD	Prospect	q. m.	Q vein (stringer)	x x 100	
Plymouth (Pinyon)	SE¼ 25	28 S.	35 E.	MD	Prospect	q. m.	Q vein		FeO_x
Pride of Mojave (incl. Four Star)	NW¼ 33	11 N.	12 W.	SB	50-ton mill	q. m.	Q in C vein	x x 265	Au, Ag, Pb, Cu, W
Prize	SW¼ 28	27 S.	40 E.	MD	Prospect	q.m., di. dike	shear zone	1 x x 60-80	FeO_x
Rademacher (Barron)	S½ 29	27 S.	40 E.	MD		grd. gneiss	silic. shear zone	½± x 1000 x 250	Au, FeO_x, Cu
Red Strike	W½ 34	29 S.	36 E.	MD	None(?)	q. di.	Q vein	1/3-1 x 200 x 100	FeO_x
Red Wing	SW¼ 26	27 S.	40 E.	MD	See Huanita	gr. rhy. dike	Q vein	1/3-3 x 5000 x 170	Au
Reward	34	27 S.	40 E.	MD	Minor	q. m.	Q vein	x 80 x 65	Au, FeO_x
San Antonio	NW¼ 23	29 S.	36 E.	MD	Small	q. m.	Q vein	1 x 900 x 165	Au
Sidewinder	W½ 28	29 S.	36 E.	MD	Prospect	q. di.	Q vein (stringer)		
Sky Line	8	31 S.	36 E.	MD	<$25,000	grd.	Q vein	2-8 x 1000 x 250	Au
*Standard (Exposed Treasure)	NE¼ 32	11 N.	12 W.	SB	$3,500,000	q.m., rhy. por.	Q veins	2-20 x 3,000 x 900	Au,Ag,Pb,Cu,Fe, As
Stardust No. 1	SW¼ 32	27 S.	40 E.	MD	Prospect	q. m.	shear zone	5 x x	FeO_x,MnO_2,CuCO
Stellar	22	27 S.	40 E.	MD	Not large(?)				
*St John	4 33	29 S. 28 S.	35 E. 35 E.	MD MD	>$700,000 (1860-1950)	grd.	Q vein	½-4 x 500 x 600	Au,FeS_2,Sb, As,Pb
Summit prospect	NE¼ 25	28 S.	35 E.	MD	Prospect	q. m.	Q veins (stringers)		
Upper Sageland	19	28 S.	35 E.	MD	Few 10's oz			x x 175	Au,Ag,Cu
Vera Queen (Indian Wells Valley)	NW¼ 22	27 S.	40 E.	MD	Minor(?)	grd.	Q vein	1-3½ x 400 x 100(?)	Au,FeO_x Mn, Cu
White Star prospect	18, 19	27 S.	40 E.	MD	Prospect	granitic	Q vein	x x 60	
*Whitmore	32	11 N.	12 W.	SB	>2,250 oz	q.m., rhy.	Q veins	2-6 x 400 x 300	Au,Ag,FeS_2,As
*Yellow Dog	W½ 32	11 N.	12 W.	SB	>5,850 oz	q.m., rhy. por.	Q vein	4-10 x 1,000 x 336	Au,Ag,FeS_2,As
Yellow Treasure	W½ 26	27 S.	40 E.	MD	Small, Au, Cu	q. m.	Q vein	3-6 x 600 x	Au,Cu,Pb, Ag,FeO_x

LEAD

Lead has not been produced in the El Paso West area except as a byproduct of gold mining. Troxel and Morton (1962) list two lead prospects in the area:

Name	Location (MDBM)			Production
	Sec.	Twp. S.	Rge. E.	
Carbonate	NE¼ 6	31	37	None(?)
Lead Mine, The	35	27	40	None(?)

Carbonate prospect. A caved shaft and short adit extended S. 80° W. from the shaft exposed traces of galena, chalcopyrite, and copper and iron stains in fractured fine-grained granitic rock. Gypsum, clayey gouge, and calcite are common in fractures.

The Lead Mine. A 25-foot open cut excavated sometime prior to 1904 exposed a "lead carbonates and sulfide 'deposit' with two veins 6 inches and 8 inches wide on sides".

LIMESTONE

Limestone and dolomite bodies in Kern County are parts of roof pendants as much as 25 miles long and 4 miles wide in Cretaceous intrusive rocks. Most of them occur in two belts: one belt 35 miles long and 4 miles wide trends northeast near the Garlock fault from Frazier Park nearly to Mojave, the other 50 miles long and 25 miles wide trends north from Tehachapi to Kernville. The pendants are chiefly mica schist, quartzite, and hornfels; carbonate rocks comprise 15-30 percent of the major pendants.

In the El Paso West area the most easterly major pendant in the north-trending belt contains several lenses of limestone that crop out on both sides of Dark (Back) Canyon. Large reserves probably suitable for portland cement are indicated.

Name	Location (MDBM)			Production
	Sec.	Twp. S.	Rge. E.	
Dark Canyon	24	30	34	None
	30	30	35	None

MERCURY

The only commercial source of mercury in Kern County has been the Walabu mine (T. 31 S., R. 32 E., MDBM). Of four other deposits only two, the Mammouth and Tardy prospects, are in the El Paso area.

The Mammouth prospect (NE cor. sec. 10, T. 31 S., R. 36 E., MDBM) has no record of production but a few tons of ore were retorted. The ore body is a mineralized zone about 18 inches wide and a few tens of feet long in the center of a vertical septum 6 feet wide and a few hundred feet long of shattered sedimentary rocks recemented with aragonite(?) and enclosed in granite. Cinnabar occurs in wispy veinlets and disseminated fine grains in aragonite(?) and around inclusions of altered granite and carbonate rock in the septum. Average content of cinnabar in the ore zone is estimated to be 0.025 percent or less.

At the Tardy prospect (sec. 1, T. 31 S., R. 36 E., MDBM) quicksilver is reported to occur in an igneous dike in granite.

QUARTZ

There has been no production of quartz from the El Paso West area although one deposit was tested and some development work done about 1957. The Great White Way deposit (NW¼ sec. 16, T. 27 S., R. 36 E., MDBM) was reported to assay 99.3 percent SiO_2 and 0.06 percent "iron". Access to the deposit is difficult.

ROOFING GRANULES

Kern County has yielded a significant proportion of the roofing granules produced in California since 1950--about 15,000 tons valued at about $160,000 in 1957. Two of the producers have quarries in the El Paso West area:

Name	Location (MDBM			Production
	Sec.	Twp. S.	Rge. E.	
Groover Mining and Milling Co.	14, 23, 28	30	36	500 tons/mo
Mojave Mineral Products Co.	10, 11, 14, 15	30	36	40 tons/day

Groover Mining and Milling Company and its successor(s?) produced roofing granules in four colors, "Emerald green," "Seafoam green," rose bronze," and "vintage red," from quarries in Jawbone Canyon within 2 miles of the mill in sec. 14. Both shades of green granules are obtained from quartz latite and rhyolite tuff-breccia of Tertiary age. The tuff-breccia on Blue Point hill in sec. 14 is also a possible source of dimension stone at least as large as 5 x 6 x 9 feet. The tuff-breccia crops out continuously for about one-fourth mile and is about 100 feet thick. Both shades of red granules are made from granodiorite of Cretaceous(?) age. The colors are due to abundant salmon-colored orthoclase (sec. 28) and to weathering (sec. 23).

Mojave Mineral Products Company and its successor(s?) produced roofing granules in six colors, light green, blue green, purple, bronze, pink, and blue. All quarries are in Tertiary volcanic rocks and tuffaceous sedimentary rock exposed just north of Blue Point, Jawbone Canyon.

SAND AND GRAVEL

None of the major sources of sand and gravel in Kern County is in the El Paso West area; one pit is listed by Troxel and Morton (1962).

The Grossard pit in sec. 28, T. 25 S., R. 38 E., MDBM, is one of at least three sources of concrete aggregate for use in Ridgecrest and in Inyokern where the plant is located. The pit is in an alluvial fan of Holocene age below the mouth of Grapevine Canyon on the east slope of the Sierra Nevada.

SILVER

Most of the silver produced in Kern County--about $6 million worth through 1958--has been a by-product of gold mines. Only one deposit in the El Paso West area is classed as primarily silver.

The Big Four prospect (SE cor. sec. 26, T. 30 S., R. 36 E., MDBM) is a north-trending, west-dipping, silver-bearing vein a few inches in maximum width in Tertiary sedimentary rocks. Five claims were under development in 1959.

STONE

Small amounts of stone have been produced from each of two deposits in the El Paso West area:

Name	Location (MDBM)			Production
	Sec.	Twp. S.	Rge. E.	
Mary	E½ 30	30	36	Few tons-rubble
You-name-it	E½ 26	30	36	Small-building stone

The Mary deposit is a rhyolite plug several tens of feet wide high on the south side of Jawbone Canyon. Rhyolite with a moderate amount of iron staining was selectively mined in 1956 or 1957 from a pit about 6 feet wide and 10 feet long. Brown iron-stained rhyolite dikes border the plug. Small vertical rhyolite dikes crop out also on the north side of the canyon. Several tens of thousands of tons of rhyolite are available in the area.

The You-name-it deposit is a sedimentary bed of Tertiary age about 50 feet thick that dips gently west and crops out continuously for about 2 miles. It is composed of coarse- to fine-grained continental sediments, mostly volcanic debris, that are generally white but are irregularly iron stained. Small amounts of stone with concentric iron stains have been mined since 1954 for use as building stone. The Big Four silver prospect occurs in the same sedimentary formation.

THORIUM

Thorium minerals have not been produced commercially in Kern County, but thorium-bearing monazite is a minor accessory mineral in the Mesozoic granitic rocks, and in the El Paso area one occurrence of francolite was found in 1955 while prospecting for uranium.

At the Wilkerson No. 1 prospect (NW¼ sec. 33, T. 26 S., R. 38 E., MDBM) coarse conglomeratic arkose and sandstone of probably Pliocene age contain bone material replaced by francolite, a variety of apatite. The deposit is not presently (1962) of commercial interest.

TUNGSTEN

Most of the tungsten mines in Kern County are in the Sierra Nevada or in the Rand district. Most of those in the Sierra Nevada are on the west side of the range, but a few are on the east side and 10 of these are in the El Paso West area.

Name	Location (MDBM)			Production
	Sec.	Twp. S.	Rge. E.	
Blue Point	10,11, 14,15	30	36	<1 ton
Fernandez	34,35	25	37	Small(?)
F.O.B. (Pyavin)	11,12	26	37	Small(?)
High-Low	29	30	36	$12,000±
*Hi-Peak	10,15	26	38	>50 tons ore
Kertung	24	26	37	Prospect
Magnolia (Bechtle)	2	26	37	Some. See Nadeau gold
Miller	11,12	32	35	Prospect (1955)
Sierra Tungsten	SW¼ 35	25	37	?
Snow White	NE¼ 34	25	37	Small

*See text (Troxel and Morton, 1962).

Blue Point prospect. A few hundred pounds of ore and specimens have been produced from small open cuts, shafts, and trenches. Crystals of wolframite and scheelite occur in widely separated small lenses in brecciated sericitized granite along a west-trending zone half a mile long and one-fourth of a mile wide.

Fernandez group of six claims. Workings consisted in 1956 of several hundred feet of bulldozer cuts, four short adits, and a shallow shaft. Scheelite occurs in discontinuous lenses and as crystals up to an inch in diameter in tactite bodies a few feet to several hundred feet long in diorite. A few tens of tons of tactite containing 0.2-0.45 percent WO_3 were exposed in the adits. Scheelite occurs also in quartz veins: one vein from 4 inches to 2 feet wide assayed 0.18 percent WO_3 across 2 feet.

F.O.B. group of 20 claims. Exploration and mining by trenching and short drift adits mostly on F.O.B. No. 2 claim resulted in an undetermined production before 1950 and a small production in 1950. Scheelite occurs in tactite layers as much as 12 feet thick and several tens of feet long commonly adjacent to limestone in metasedimentary rock. Ore bodies are discontinuous within the tactite. Grade of the ore is locally as much as 3 percent WO_3, but probably averages 1 percent or less.

High-Low mine. About $12,000 worth of ore was mined in 1954 from a 60-foot inclined shaft. A 10-foot shaft, a 30-foot drift adit, and several shallow pits may also expose scheelite, which occurs in irregular fractures in granodiorite. The ore mined from the shaft averaged 0.5 percent WO_3.

Hi-Peak mine (23 claims and a millsite). Intermittent shipments were made during 1942 to 1957 (50 tons in 1942) of ore mined from about 3,500 feet of workings on three levels off a 200-foot crosscut adit and an inclined shaft. Scheelite, and locally small grains of pyrite, chalcopyrite, and arsenopyrite, occurs as disseminated fine to coarse grains in tactite lenses from 1-20 feet wide, several feet from top to bottom, and a few tens of feet long, in a roof pendant 50-150 feet wide and 800 feet long of metamorphosed pre-Cretaceous sedimentary rocks in Cretaceous(?) quartz monzonite. The best ore is in tactite near limestone. Average grade of the ore is not known, but ore mined in 1956-57 contained 0.5-2.0 percent WO_3 (Troxel and Morton, 1962, p. 301).

Kertung group (9 lode, 3 placer claims). A small production may have resulted from rich float in nearby canyons, and from three small prospect pits on the ridge crest between Freeman and Indian Wells canyons. Scheelite-bearing lenses a few inches thick and a few feet long of tactite occur in metasedimentary rocks which strike northwest and dip steeply northeast.

Magnolia mine (9 lode claims). Some scheelite was mined in 1952 from drift adits a few tens of feet long. Gold ore containing 2/3 oz gold per ton was mined in 1938-39 from a vein on the same(?) property. Scheelite occurs in tactite lenses 1-1½ feet wide in a limy stratum nearly 3,000 feet long. Gold-bearing quartz veins are in granitic rocks.

Miller prospect. Production from the property, which was being developed in 1955, is not known. Scheelite occurs in tactite in small roof pendants that contain some limy strata.

Snow White prospect. A small production in 1953 was reported. The principal development is a drift of undertermined length driven northwest. Scheelite occurs in tactite lenses in metasedimentary rocks that strike northwest and dip steeply northeast.

URANIUM

Uranium deposits are widely scattered through Kern County but only a few have warranted more than shallow exploration. Of 43 deposits listed by Troxel and Morton (1962) the most productive are the Kergon, Little Sparkler, and Miracle mines in Kern River Canyon (T. 27 S., R. 32 E., MDBM). The first uranium ore produced in California (July 1954) was from the Miracle mine, but all three mines were closed by 1958 after producing 400 tons ranging in grade from 0.16 to 0.62 percent U_3O_8. The Miracle mine, however, has been worked part time since then.

In the El Paso West area, five deposits were explored during 1954-57.

Name	Location				Production
	Sec.	Twp.	Rge.	Base Meridian	
Emerald Queen	34(?), 35(?)	32 S.	35 E.	MD	None(?)
M A K	26	32 S.	38 E.	MD	7 tons ore
*Miller Ranch	SE¼ 1	30 S.	36 E.	MD	None(?)
Nob Hill	NW¼ 26	32 S.	38 E.	MD	None
Silver Lady	SE cor. 10	30 S.	36 E.	MD	None
Vanuray (see CLAY)	26	11 N.	8 W.	SB	None

*See text (Troxel and Morton, 1962)

Emerald Queen. Secondary uranium minerals occur as fracture coatings or disseminated in tuffaceous sandstone. A sample contained 0.054 percent U_3O_8.

M A K prospect. About 7 tons of ore was mined in 1954 or 1955 from shallow trenches in an area of several hundred square yards that was scraped clear by bulldozing. Spots of highest radioactivity appear to have been explored by shallow drilling. Unidentified uranium minerals occur along shear zones that strike west and dip 70° N. in volcanic flow-layered rocks of Tertiary age.

Miller Ranch. No production resulted from exploration by a 20-foot drift adit, an open cut that removed most of the hilltop and the adit, another 90-foot adit 100 feet below the crest of the hill, and by other cuts and trenches. An earlier 150-foot adit was driven in search of gold. Secondary uranium minerals occur along intersecting fractures in four separate bodies of rhyolite that overlie granite. The rhyolite bodies are poorly exposed by discontinuous outcrops. The largest body is most extensively explored: it is about 300 feet wide, 50 feet or more long, and perhaps 100 feet deep. Other bodies are about 15 feet across. The highest concentration of autunite, schroeckingerite, and uranophane appears to be in a zone of closely spaced vertical fractures that strike east in the largest rhyolite body.

Nob Hill claims. No production resulted from exploration by trenching, bulldozer scraping, and drilling. Unidentified radioactive minerals occur in a zone 4 feet thick along flow planes in volcanic flows, tuffs, and agglomerates of Tertiary age that strike N. 45°-80° E. and dip 30°-50° SE., particularly near iron-stained shears which strike N. 60°-75° E. and dip steeply.

Silver Lady group of three claims. Development consists of an 18-foot prospect shaft for tungsten or molybdenum (see Blue Point tungsten), shallow trenches, open cuts, and one drill hole inclined southward from the north side of a major fault zone. Metatorbernite and unidentified uranium minerals occur along shears in a vertical fault zone 50-70 feet wide and at least 2,000 feet long that strikes N. 70° W. in volcanic and sedimentary rocks of Tertiary age. Fault breccia is locally altered to quartz-sericite. A channel sample assayed 0.71 percent U_3O_8; selected specimens contained as much as 31.1 percent U_3O_8.

Vanuray claim. The prospect is an open pit about 18 feet deep and 100 feet in diameter (originally worked for clay). The pit walls are locally radioactive. Carnotite occurs with opal and minor amounts of iron and manganese oxides as fracture coatings in shear zones as much as 1½ feet wide, and also as sparse disseminations in and adjacent to the shear zones in sandy clay of Miocene age. A grab sample where the radioactivity was highest assayed 0.056 percent U.

Red Mountain North area
San Bernardino County, California
(Secs. 34, 35, and 36, T. 26 S., R. 41 E., MDBM)

NO MINERAL DEPOSITS

Red Mountain South area
San Bernardino County, California
(T. 31, 32 S., R. 44 E., MDBM)
(T. 10-12 N., R. 4-7 W., SBBM)

Only three mines are listed in this area by Wright and others (1953), one under feldspar, one under gold, and one under perlite. In addition, gem material has been reported, and saline deposits have been suspected.

FELDSPAR

Nearly all the feldspar produced in San Bernardino County, possibly 18,000 tons as of 1952, came from the White Butte deposit in the Red Mountain South area.

The White Butte deposit (sec. 18, T. 31 S., R. 44 E., MDBM) yielded about 17,000 tons of ceramic-grade feldspar since it was opened in 1940 through 1951 from an open cut 125 feet wide, 200 feet long, and 30 feet deep. The deposit is a pegmatite podlike body about 200 feet wide and 300 feet long in Cretaceous(?) quartz monzonite. Nearly two-thirds of the body is microcline; most of the other one-third is quartz which occurs in lenses as much as 60 feet long, and in veinlets. Minor accessories include biotite, sericite, and albite.

GEMS

"Veinlets of colorful mossy jasper, mostly ochre-yellow, are found in the basalt of unit 5 [top] of the lower part of the Tropico group in the northern Kramer Hills in the NE¼ sec. 33, T. 10 N., R. 6 W." (Dibblee, 1960, p. 132).

Opal occurs in numerous veinlets less than a quarter of an inch thick in white lithic tuff of the Pickhandle Formation in the area of Opal Camp or Scouts Cove, SE¼ sec. 36, T. 31 S., R. 44 E. The opal now exposed is translucent honey yellow, but it is said that fire opal was found here years ago. Prospects consist of two vertical shafts about 50 feet deep (Dibblee, 1968, p. 61).

GOLD

Although gold is the most widely distributed metal of commercial value in San Bernardino County, total recorded production from 1880 to 1950 was only $12,148,353. The Bagdad-Chase mine (secs. 7, 8, T. 6 N., R. 8 E, SBBM) yielded more than half the total.

In the Red Mountain South area, only one deposit is listed by Wright (1953). Coolgardie placers (secs. 2, 3, 4, T. 11 N., R. 3 W., SBBM). Gold placer deposits worked by dry methods. First operated about 1900. Little activity since the 1930's. Estimated total production to 1930 is about $100,000.

One other gold mine is listed by Bowen (1954, p. 126). The Kramer Hills and Herkelrath (Shaherald) mine in sec. 35, T. 10 N., R. 6 W., was discovered and had a small production in 1913. A 200-ton mill was built near the West shaft. Gold occurs in brecciated quartz veins along the schistosity and in the wallrock of a roof pendant of Triassic Sidewinder schist in quartz monzonite. Small pockets of high grade were found but most ore averaged about $4.50 per ton.

Several gold prospects are shown on the geologic map of the Fremont Peak and Opal Mountain quadrangles (Dibblee, 1968, pl. 1) but no production has been recorded.

PERLITE

Although there are large perlite deposits in Kern County in the Castle, Bristol, and Turtle Mountains, production has been small, and only those in the Castle Mountains have been worked commercially.

In the Red Mountain South area, the Hicks perlite deposit (secs. 35, 36, T. 31 S., R. 44 E., MDBM) yielded a small tonnage for experimental purposes. Perlite occurs in lensshaped bodies of various sizes in rhyolite flows of Tertiary age interlayered with beds of tuffaceous sediments. The Hicks perlite is light to dark gray in color, highly brecciated, and commonly traversed by numerous veinlets of pink chalcedony and opal.

PETROLEUM

Prospecting for petroleum and gas has been carried on for many years in Harper Valley. Five unsuccessful holes were drilled to depths of 450 to 2,468 feet in T. 11 N., R. 3 and 4 W. Four others 856 to 1,755 feet deep in T. 11 N., R. 6 W. were also unsuccessful. Dibblee (1968, p. 62) concluded that because there are no marine source beds in the Tertiary strata and because pre-Tertiary rocks are highly metamorphosed, the area is unfavorable for oil. A little gas could have formed from organic matter in the Barstow Formation and some may have accumulated in the Black Canyon anticlinal dome (T. 32 S., R. 44 E., MDBM) in porous sands that may be present in the lake bed clays.

135m 750m

SALINES

The alluvial basin north and south of Kramer Junction (Four Corners) was drilled for borates by the U.S. Geological Survey, with the following results (Dibblee, 1960, p. 135: 1968, p. 62):

Hole	Location (SBBM)			Depth (feet)	Salines
	Sec.	Twp. N.	Rge. W.		
Four Corners 1	20	10	6	T.D. 3,500	None
Four Corners 2	5	10	8	T.D. 2,328	None
USGS No. 3	18	11	6	1,020-1,460	7% - 20% B_2O_3
USGS No. 4	30	11	6		
USGS No. 5	30	11	6	1,051-1,131	14% B_2O_3

Holes 3, 4, and 5 penetrated lake-bed shales containing colemanite in thin layers a fraction of an inch to several inches thick distributed in as much as 76 feet of shale at depths between 1,020 to 1,460 feet. The B_2O_3 content of intervals 2 feet or more thick range from 7 percent to 20 percent. Colemanite was most abundant in hole 5 where 76 feet of core averaged 14 percent B_2O_3. The deposit probably covers about 500 acres (Dibblee, 1968, p. 62).

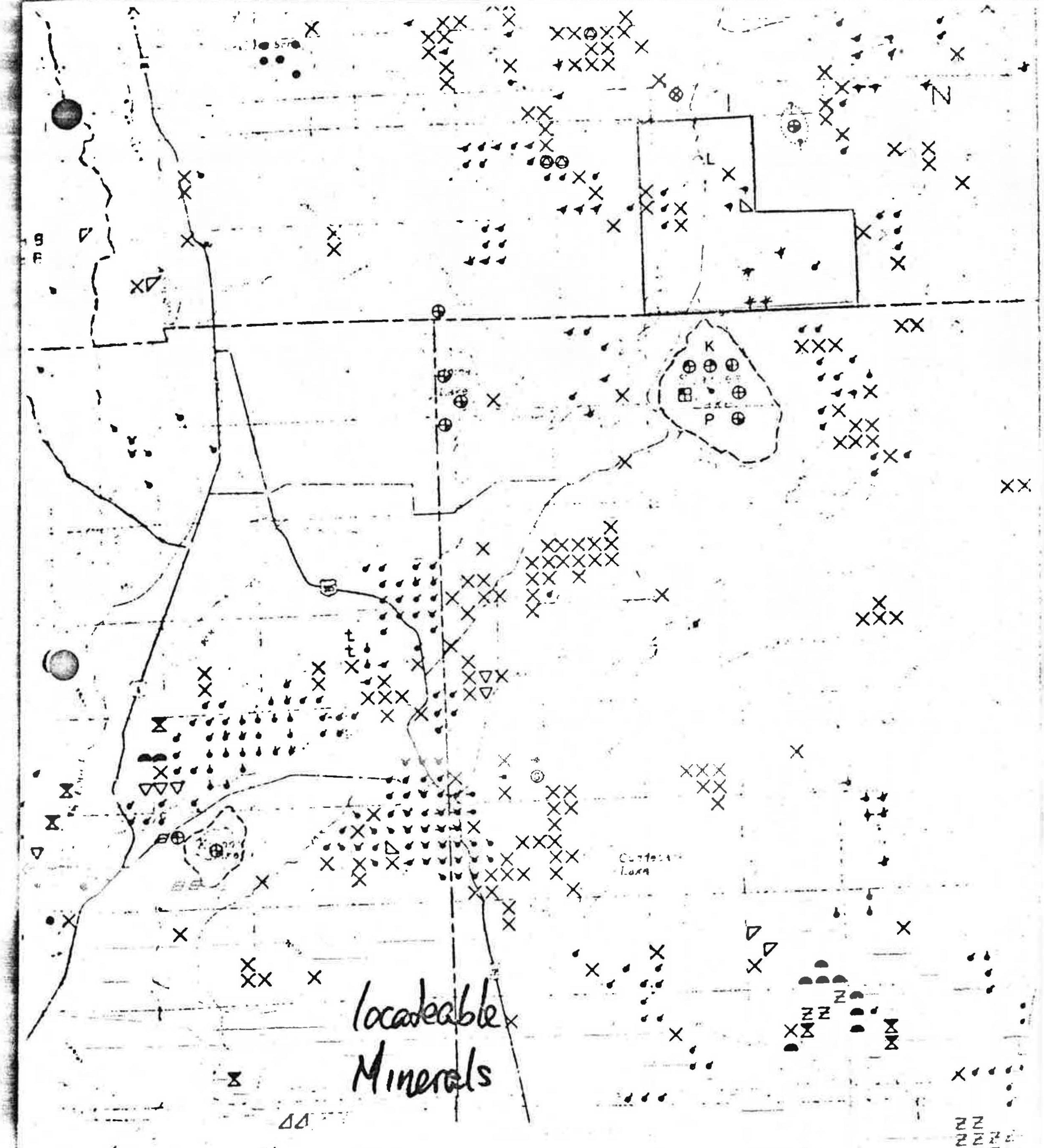
Northern Searles Valley area
Inyo County, California
(T. 23 S., R. 42, 43 E., MDBM)
(T 24. S., R. 42-44 E., MDBM)

MINERAL CLASSIFICATION

Different overlapping parts of the area are classified by the Conservation Division, U.S. Geological Survey, as having known or prospective value for sodium and potassium, for oil and gas, and for geothermal energy, as shown on the following maps. The classification for sodium-potassium (Fig. 9) represents mineral leases, prospecting permits, applications, and areas inferred to contain salines based on geologic maps (Smith and others, 1968). The oil-gas and geothermal energy maps (Figs. 10 and 11) represent areas considered to have prospective value based on geologic maps and on Water Well No. 32. There is currently an application for a geothermal lease in northern Searles Valley.

Selected occurrences of locatable minerals are shown on Figure 12, and names of mines and prospects are listed in Table 8.

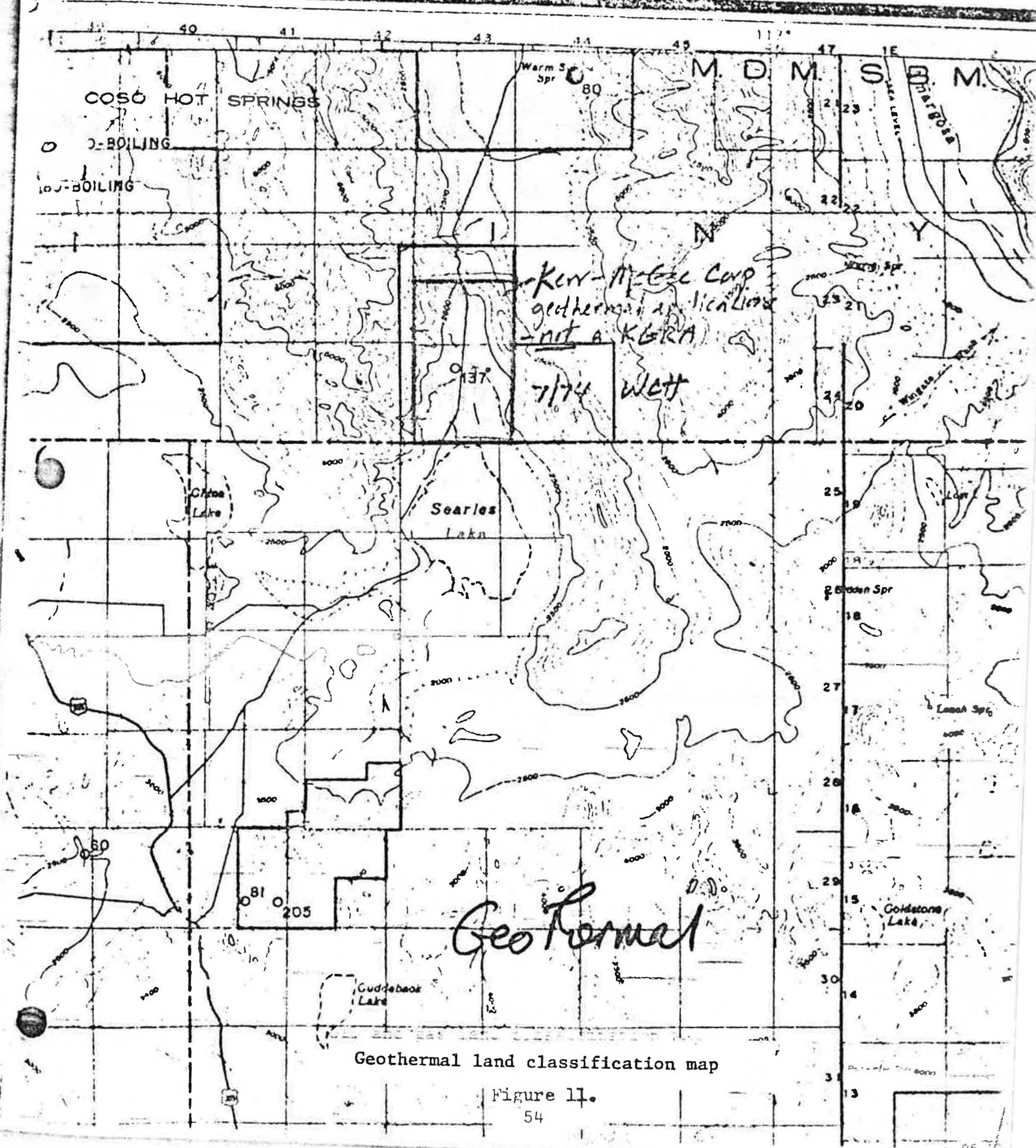
The Conservation Division of the U.S. Geological Survey has the legal responsibility for classifying land with respect to leasable minerals, but not for locatable minerals. The pertinent areas currently classified are shown on Figures 9, 10, and 11.



locateable Minerals

Reported occurrences of selected minerals in southern one-third of California

Figure 12.



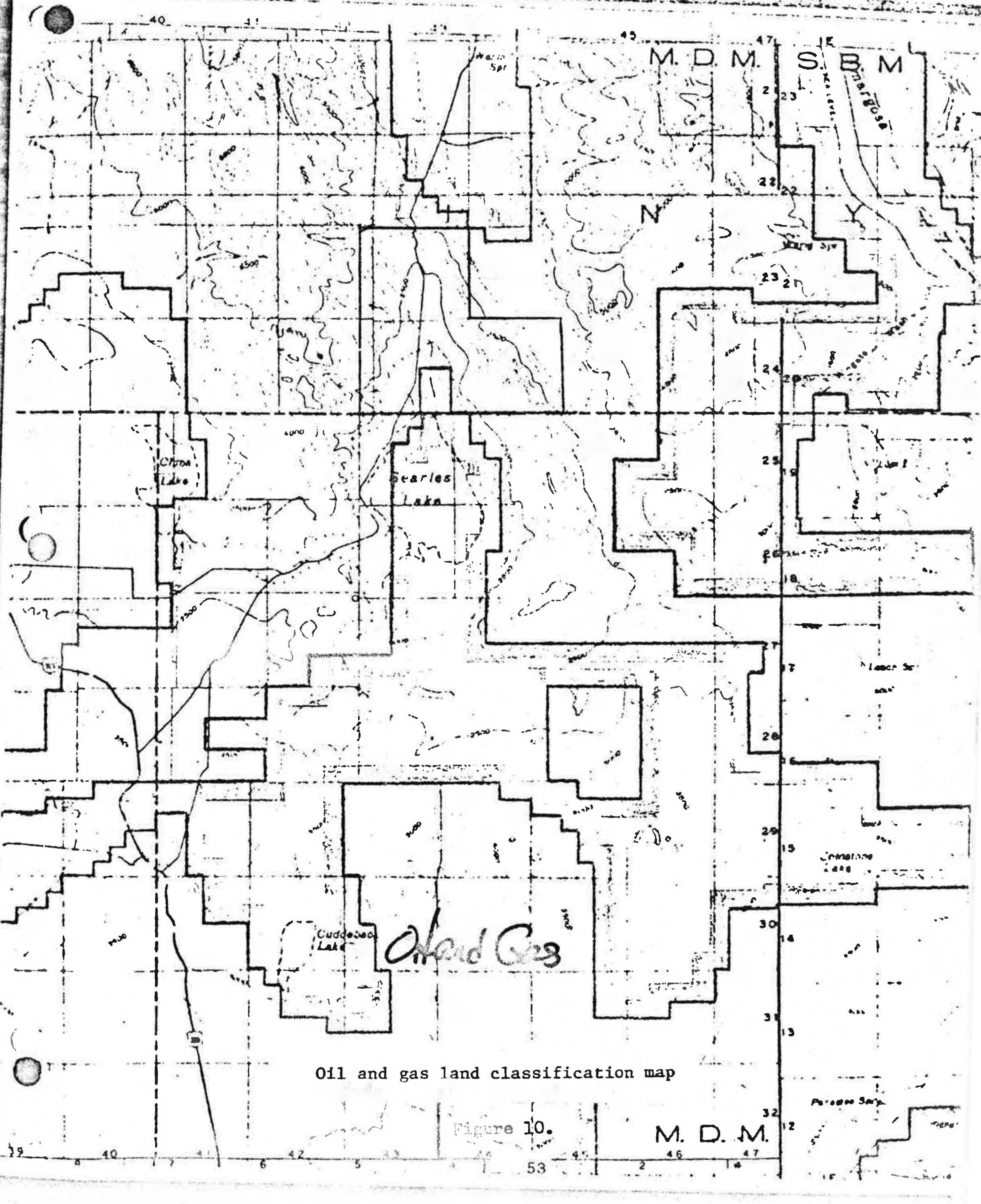
Kerr-McGee Corp geothermal applications - not a KGRA

7/74 Well

GeoThermal

Geothermal land classification map

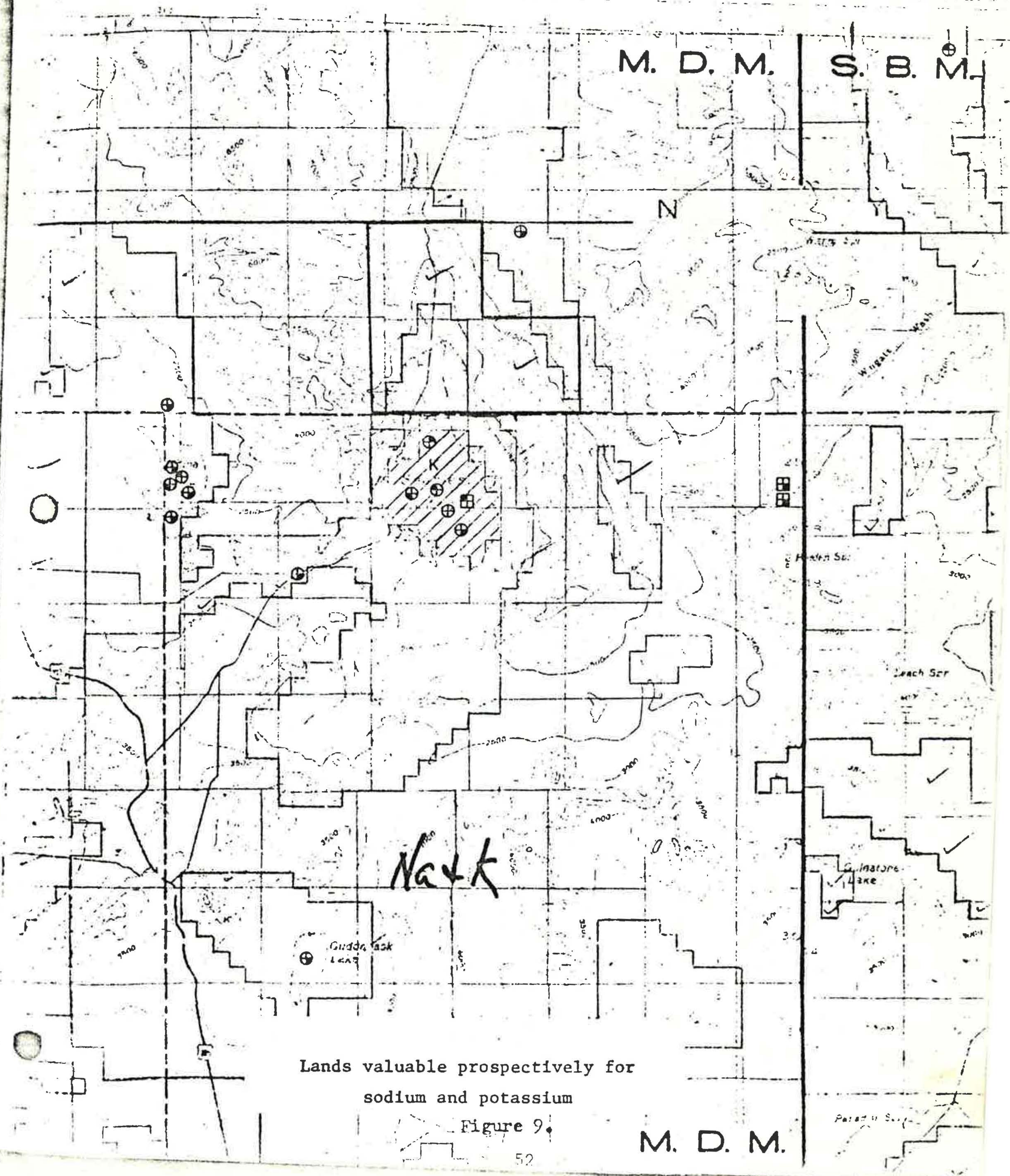
Figure 11.



Oil and gas land classification map

Figure 10.

ii



Lands valuable prospectively for sodium and potassium

Figure 9.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MR 47, 48, AND 49

REPORTED OCCURRENCES OF SELECTED MINERALS IN CALIFORNIA

Includes most metals and nonmetals; does not include
petroleum and natural gas

Compiled by
Merritt B. Smith, Vivian L. Engler, Della I. Lee
Katherine J. Horn, and Russell G. Wayland

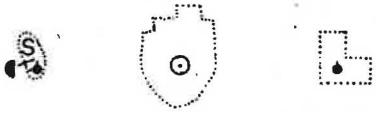
1967

EXPLANATION

Symbols show reported locations of mines, prospects, and occurrences of selected minerals. Inactive mines are not distinguished, nor is the size or grade of the mineral occurrence indicated. Multiple occurrences of the same mineral within a section are not differentiated from a single occurrence. However, certain symbols such as those for gold, silver, copper, lead, zinc, and tungsten may be combined to show several different minerals in the same locality.* Symbols are shown both according to an alphabetical mineral list and by related groups of symbols

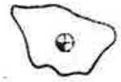
The following minerals are excluded: petroleum, natural gas, oil shale, pumice, cinders, and common varieties of clay, sand, gravel, and stone. Low-grade occurrences of some metals, especially manganese and copper, are not shown. Occurrences of widespread nonmetals, such as limestone, diatomite, and gypsum, are not shown unless currently exploited on a large scale, containing large reserves, or of unique character

Each mineral occurrence is located to the nearest section within a township, but for some minerals of widespread distribution or numerous occurrences an area is outlined

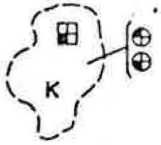


Areas of numerous or widespread mineral occurrences

Leadered symbols also indicate widespread occurrences within areas



Principal minerals in lake water



Principal minerals in intermittent or dry lake

Ⓖ

Geothermal resource

×

Mine or prospect where mineral is unknown

Copper, lead, and zinc

Chromium and nickel

*Examples of combined symbols

METALS

RELATED SYMBOLS

•	Copper
•	Gold
•	Lead
•	Molybdenum
•	Silver
•	Tungsten
•	Zinc
●	Mercury
✕	Chromium
✕	Cobalt
✕	Nickel
✕	Platinum
⊚	Iron
⊚	Titaniferous iron
◉	Titanium
⊗	Antimony
⦶	Arsenic
⊖	Bismuth
ⓔ	Rare earths
⧗	Uranium
⧗	Vanadium
⋈	Tin
⋀	Beryllium
△	Columbium, tantalum
◺	Manganese
C	Cesium, rubidium
Th	Thorium

NONMETALS

RELATED SYMBOLS

⊕	Borates
⊕	Sodium carbonate
⊕	Sodium chloride
⊕	Sodium sulfate
⊕	Lithium minerals
⊙	Diatomite
◑	Strontium minerals
○	Talc, soapstone, pyrophyllite
A	Asbestos
B	Barite
C	Carbon dioxide
F	Fluorite
K	Potash
L	Limestone
N	Nitrate
M	Magnesite
P	Phosphate
S	Sulfur
t	Wollastonite
Z	Sodium zeolite
⊞	Bromine
⊞	Calcium chloride
⊞	Magnesium sulfate
⊠	Mica
⊡	Nepheline
⊡	Silica sand
▰	Abrasives
◣	Asphalt, bituminous rock
◢	Coal
◥	Quartz, crystal
◒	Kaolin
◓	Gem and ornamental stones
◖	Mineral pigments
M	Graphite
▱	Calcite, optical
▱	Gypsum
◸	Feldspar
◿	Fuller's earth
▽	Bentonite
A	Kyanite, andalusite
V	Vermiculite

Table 8.--Mines and prospects

Northern Searles Valley area, Inyo County, California

[References: Norman and Stewart, 1951; Smith and others, 1968;
U.S. Geological Survey, Conservation Division, 1974]

Mine name	Location (MDBM)			Commodity	- Production
	Sec.	Twp. S.	Rge. E.		
Alice	21	23	42		
American - see Copper Queen	31	24	44		
Arondo (Arando, Oronodo)	NW¼ 30	23	43	Au	- Cyanide plant
Blue Moon Group		23	42	Au(?)	-
Buster Group		24	42	(?)	-
California Queen No. 4	7(?)	24	43	Ag, Pb	- (?)
Copper Clame	Approx	24	43	Cu, Pb, Ag, Au	- >10,000 lbs Cu
Copper Queen (Gold Bottom, American, Slate Range)	E½ 36 31	24 24	43 44	Pb, Ag, Zn, Au, Cu	- >$900,000
Crescent	Approx	24	44	Ag, Pb	Small 1924
Daily Dozen - see January Jones					
Davenport	30	23	43	Au	- $50,000
Four Leads	Approx	24	43	Cu	- <10,000 lbs
Gold Bottom - see Copper Queen					
Golden Trio 1 & 2	19	23	42	Au	
Gold Star Group		23	43	Au(?)	- None(?)
Graham-Jones - see Ruth					
Great Divide Ext. No. 4	33	23	42	Au, Ag, Pb	- None(?)
Grimes and Sexton	Approx	23	43	Pb, Ag, Au, Cu	- Some
Hillside Group		23	42	Au, Ag, Pb(?)	
Iron Chief	18	23	42	Fe	- None(?)
January Jones (Daily Dozen)	NE¼ 22	24	44	Au	- $75,000
Kane (Belcher Extension)	25,26,35	23	43	Pb, Ag	- None(?)
Lillie - see Mature	36	23	43	Mn	- 1953, 1954, 1955
Lilly	Approx	24	43	Pb, Ag	- Small
Los Angeles - see Mature					
Lucky Day Group		24	44	Pb(?)	- None(?)
Margaret	31	23	43	Au	- None(?)
Mature & Los Angeles (Silver King?) (Lillie - secs. 14, 15, 20, 21?)	NW¼ 36	23	43	Au, Pb, Ag Mn	None(?) - Some
McKinley-Westfalia	18 24	23 23	43 42(?)	Au	- None(?)
Mohawk	NW¼ 6	24	43	Au	- $9,000±
Mountain Springs Canyon Placers	4(?)	23	42	Au	-
New Deal		23	44	Pb, Ag, Zn	-
Ophir (Uncle Sam)	NE¼ 24	24	43	Pb, Ag, Zn, Mo	- $800,000
Oronodo - see Arondo					
Paymaster	Approx	23	43	Pb, Ag	- Some
Ruth (Graham-Jones)	SE¼ 35	23	42	Au	- >$550,000
Silver Gold No. 2	33	23	42	Ag, Pb, Au	- None(?)
Silver King (Mature?)	8 36(?)	24 23(?)	44 43(?)	Ag, Pb, Au	- None(?)
Slate Range - see Copper Queen					
Stockwell (Vernon? Fritz?)	NW¼ 17 35(?)	24 23	44(?) 43(?)	Au, Cu, Pb, Ag	- >$10,000
Summit	18	23	42	Au, Ag	- None(?)
Uncle Sam - see Ophir					
Veeta	32	23	43	Au(?)	- None(?)
Vernon - see Stockwell					
Wanderer Mines		23	43	(?)	
West End Chemical - quarry	9,10,15	23	43	Limestone	- 1,500,000 tons
Westfalia - see McKinley					
West Point	31,32	23	42	Au, Ag, Pb	- Some(?)
Unknown	3	24	42	(?)	
Do	25,26,36	23	42	Au(?)	
Do	23,35,31,32,36	23	43	(?)	
Do	25,26	23	43	Pb, Ag	- (?)
Do	[illegible]	[illegible]	[illegible]	Au	- [illegible](?)

GEOTHERMAL RESOURCES

References: Chapman and others, 1973
Hose and Taylor, 1974
Mabey, 1963
Staff - U.S. Geological Survey Conservation Division

The nearest Known Geothermal Resource Area (KGRA) is Coso Hot Springs, 30 miles northwest of the northern Searles Valley area. There are no thermal springs in northern Searles Valley listed by Waring (1965), but there are cold springs in most of the canyons in the Argus Range shown on the map of the Trona quadrangle. Water temperature at Valley Wells in sec. 21, T. 24 S., R. 43 E., MDBM, is 90°F.

Water Well No. 32 in the W½NE¼SE¼SW¼ sec. 9, T. 24 S., R. 43 E., MDBM, contains water at about 138°F. This well was drilled about 1964 by Kerr-McGee Chemical Corp. under a Special Use Permit from Bureau of Land Management covering secs. 13-36, T. 23 S., R. 43 E., and all of T. 24 S., R. 43 E. Total depth of the hole is 600 feet; it bottoms in Pleistocene sediments. Depth to the water table is about 400 feet. The purpose of the well is to furnish process water for the plant at Trona when requirements eventually exceed the capacity of other wells. A 7-mile pipeline will be required. The water is not now being used, and no pumping test has been reported.

It is possible that the hot water could be used to furnish part of the heat needed for evaporative processes, but feasibility studies have not been reported. Space heating is rarely required in this area. Geothermal power generation is not possible from water at 138°F.

Heat flow from the earth's deep interior is variable but generally higher than normal in the western United States. Within this overall pattern of high vertical conductive heat flux are several regions of low-to-normal[*] heat flow. The western Sierra Nevada region has a very low heat flow, increasing to normal near the crest of the range. Normal values were measured in the Pacific northwestern coastal region, the northwestern Columbia Plateau, and the north-central Colorado Plateau. Heat flow is high in the northern and southern Rocky Mountains and somewhat lower in the central Rockies. The Basin and Range province as a whole, including the Mojave Desert, is characterized by high heat flow, although the area between Eureka, Ely, and Mercury, Nev. is low-to-normal. Abnormally high feat flow (>2.5 HFU) characterizes the 'Battle Mountain high' area (Sass and others, 1971).

Maximum underground temperatures of hot spring waters can be estimated from their surface temperature and composition (Fournier and Rowe, 1966; Fournier and Truesdell, 1973, 1974; Fournier, White, and Truesdell, 1974).

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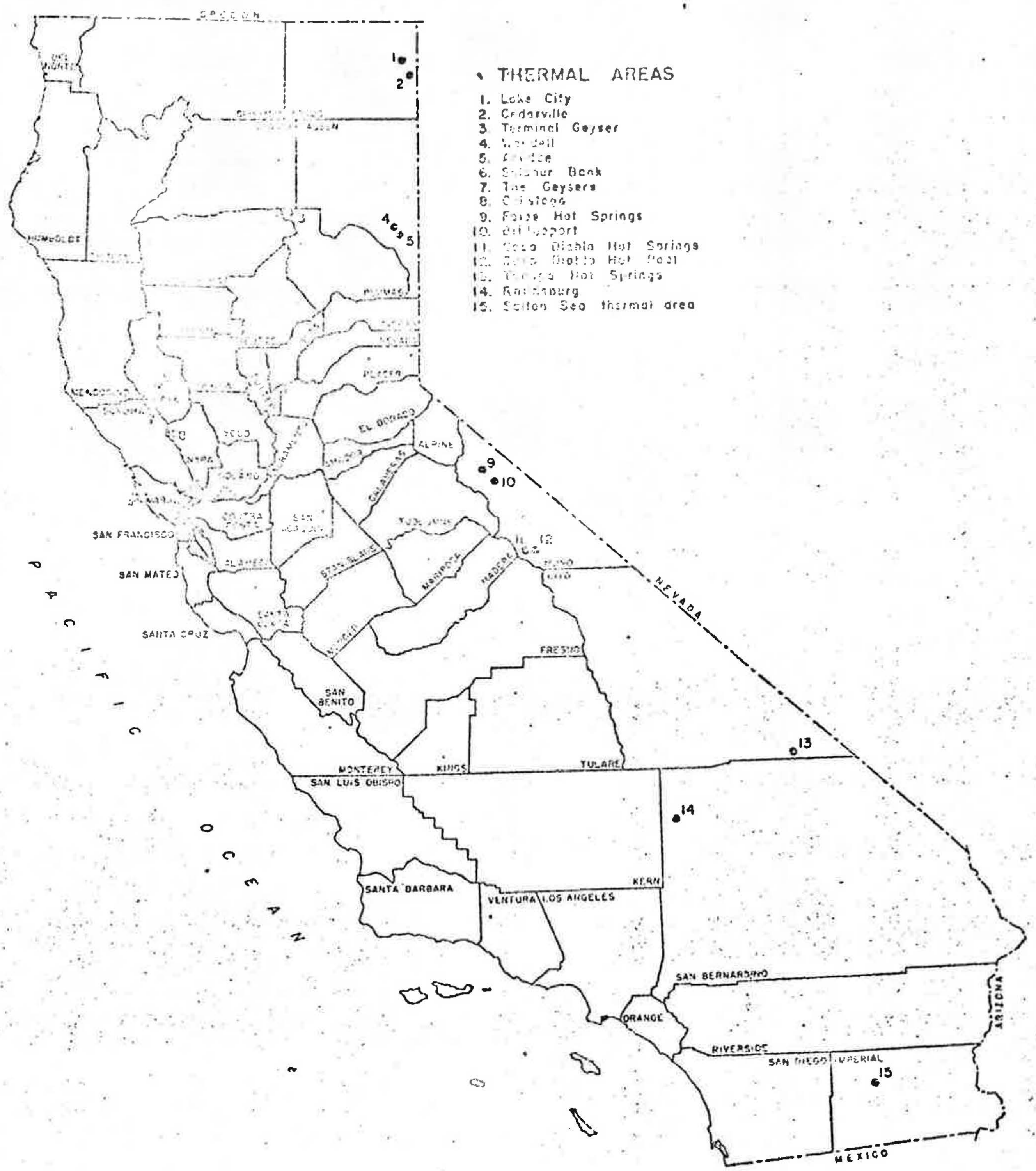
[*] Low-to-normal: ≤ 1.5 HFU (1 Heat Flow Unit = 1 μcal/cm^2 sec)
Higher-than-normal: ≥ 1.6 HFU
Abnormally high: 2.5-3.8 HFU

The geological probability of discovering a source of geothermal power in Searles Valley is low, based on current knowledge. All known actual and potential power-producing areas in North America are related to inferred silicic intrusive bodies at relatively shallow depths which are less than 10 m.y. old; older near-surface bodies have cooled. None of these power-producing areas is related to basaltic magmas, which are inferred to have been extruded directly from the earth's mantle without forming near-surface magma chambers. The geothermal area in the Imperial Valley, however, may be the result of upwelling basaltic magma related to crustal spreading. Most of the numerous thermal springs in the Basin and Range region are owing to the region's higher-than-normal thermal gradient, which in turn is owing to its thinner-than-normal crust--about 29-30 km (Hose and Taylor, 1974).

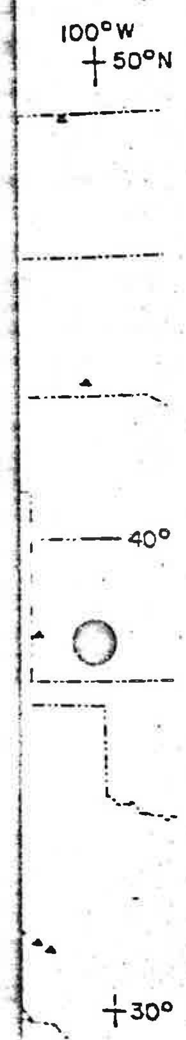
There is a small possibility, however, that a silicic intrusive may underlie the north end of Searles basin, because gravity values decrease in that locality and in the adjoining ranges. These gravity lows may indicate relief on the base of the crust, or lower densities in the crust or in the upper mantle (Mabey, 1963).

In the El Paso-Red Mountain areas no heat-flow measurements have been taken, but the areas are within the Basin and Range province, most of which is characterized by heat flows of 1.5 to 2.5 HFU (Sass and others, 1971). These characteristic values do not preclude the possibility of abnormally high heat flow in the area of the Steam Well in sec. 25, T. 29 S., R. 41 E., MDBM (Randsburg-Searles Lake report, p. 26). This area is expected to be classified as a KGRA in the near future.



McNitt, 1963

Figure 14.--Thermal areas, California



s of heat-flow
; squares, U.S.
n Figures 6, 8.
corresponding

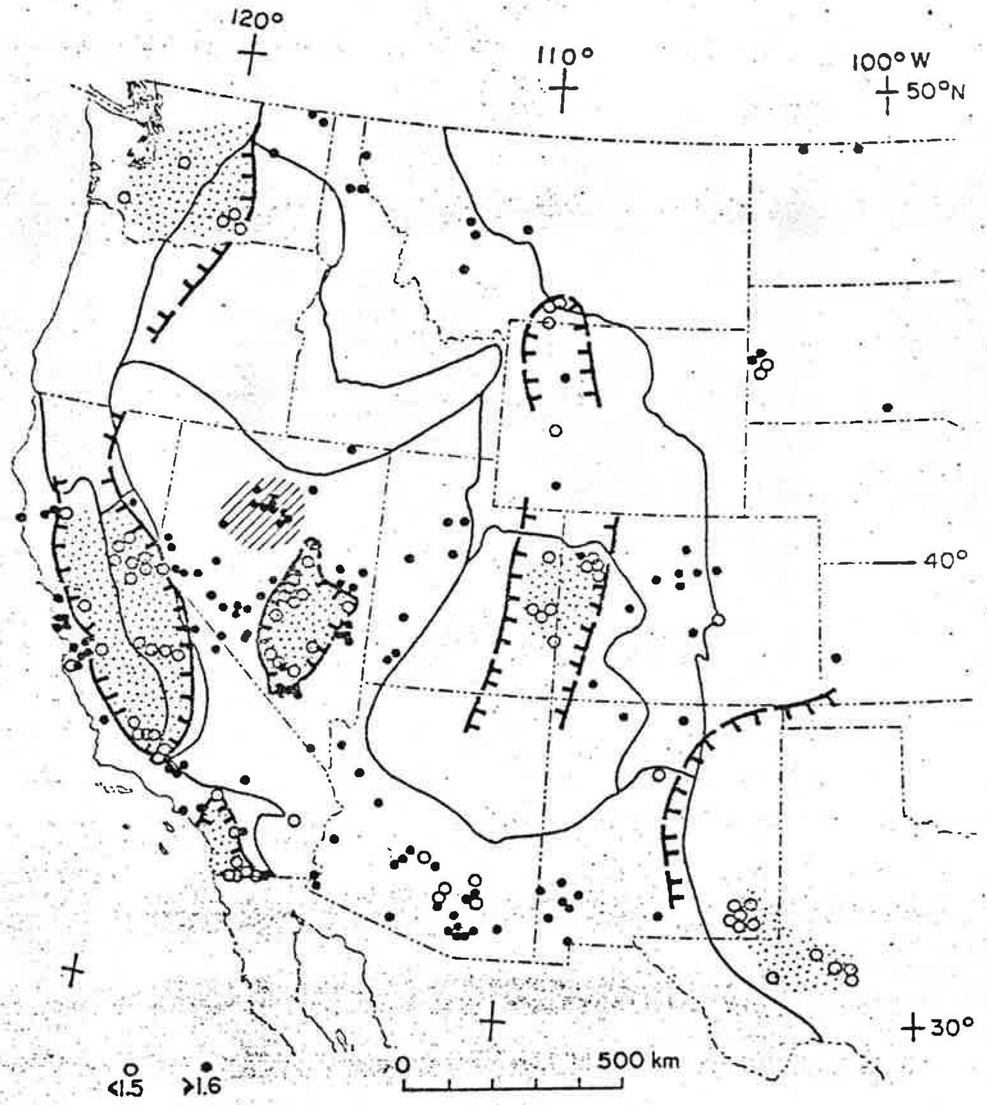


Fig. 4. Generalized representation of heat-flow data from the western United States. Stippled areas are characterized by heat flows of 1.5 and less; the heavy lines are 1.5 HFU contours. The cross-hatched area is characterized by heat flow of 2.5 and greater.

Sass and others, 1971

Figure 13

ANNOTATED REFERENCES

Assessors Handbook, Section 560, January 1973, Valuation of mines and quarries: California State Board of Equalization, Property Tax Dept., Assessment Standards Div., 154 p.

Chap. I. Nature of the mining industry
II. General geology and uses of mineral deposits
III. Mining leases, claims, and other interests
IV. Estimation of ore reserves
V. Mining accounting
VI. The appraisal process
VII. Appraisal of facilities, equipment, and inventory
Appendix - Midyear present worth factors

Bader, J. S., 1969, References for well data and water levels in California: U.S. Geol. Survey Basic Data Compilation, 13 p.

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Bowen, O. E., Jr., 1954, Geology and mineral deposits of Barstow quadrangle, San Bernardino County, California: California Div. Mines and Geology Bull. 165, 208 p.

Includes a geologic map of the Barstow 30-minute quadrangle.

Chapman, R. H., Healey, D. L., and Troxel, B. W., 1973, Bouguer gravity map of California, Death Valley Sheet: California Div. Mines and Geology, scale 1:250,000, text 8 p.

Dibblee, T. W., Jr., Geology of the Rogers Lake and Kramer quadrangles, California: U.S. Geol. Survey Bull. 1089-B, p. 73-139.

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Covers area west of Barstow (117° W. long)
List of borate mines
Lists of exploratory holes drilled for minerals, water, and oil and gas

_____1968, Geology of the Fremont Peak and Opal Mountain quadrangles, California: California Div. Mines and Geology Bull. 188, 64 p.

Table 1. Thermal areas drilled in California as of November 1962.

Thermal area	Location	Number of wells drilled	Greatest depth reached, feet	Maximum tempera-ture measured, degrees C	Date when drilled	Wells drilled by
1. Lake City	Modoc Co., Secs. 23 & 24, T. 44 N., R. 15 E.	4	2,150	160	1959-1962	Magma Power Co. (and assocs.)
2. Cedarville	Modoc Co., Sec. 6, T. 42 N., R. 17 E.	1	734	54	1962	Magma Power Co. (and assocs.)
3. Terminal Geyser	Plumas Co., Sec. 36, T. 30 N., R. 5 E.	1	1,270	129	1962	Geysers Steam Co.
4. Wendell	Lassen Co., Sec. 23, T. 29 N., R. 15 E.	1	630	79	1962	Magma Power Co. (and assocs.)
5. Amidee	Lassen Co., Secs. 8 & 5, T. 28 N., R. 16 E.	3	1,116	107	1962	Magma Power Co. (and assocs.)
6. Sulphur Bank	Lake Co., Sec. 5, T. 13 N., R. 7 W.	2	1,391	186	1961	Magma Power Co. (and assocs.)
7. The Geysers	Sonoma Co., Secs. 13 & 14, T. 11 N., R. 9 W.	22	2,100	300 (approx.)	1921-25, 1955-57 1959-61	Geyser Development Co. (1920-25) Magma and Thermal Power Cos. (1955-61)
8. Calistoga	Napa Co., Sec. 26 (projected), T. 9 N., R. 7 W.	3	2,000	137	1960-61	Calistoga Power Co.
9. Fales Hot Springs	Mono Co., Sec. 24, T. 6 N., R. 23 E.	1	413	--	1962	Magma Power Co. (and assocs.)
10. Bridgeport	Mono Co., Sec. 9, T. 4 N., R. 25 E.	1	982	51	1962	Magma Power Co. (and assocs.)
11. Casa Diablo Hot Springs	Mono Co., Sec. 32, T. 3 S., R. 28 E.	9	1,063	178	1959-62	Magma and Natural Steam Corp.
12. Casa Diablo Hot Pool	Mono Co., Sec. 35, T. 3 S., R. 28 E.	1	805	134	1961	Magma and Natural Steam Corp.
13. Tecopa Hot Springs	Inyo Co., Sec. 33, T. 21 N., R. 7 E.	1	422	--	1962	Magma Power Co. (and assocs.)
14. Randsburg	San Bernardino Co., Sec. 25, T. 29 S., R. 41 E.	1	772	116	1960	Magma Power Co. (and assocs.)
15. Salton Sea thermal area	Imperial Co., Sec. 33, T. 11 S., R. 13 E. and Sec. 10, T. 12 S., R. 13 E.	7	5,232	340	1927 1957-[illegible] 1961-62	Pioneer Development Co. (1927) Kent [illegible] O'Neill Geothermal Inc. (1961-62) Western Geothermal (1962)

McNitt, 1963

Figure 1. (Opposite page.) Map showing location of thermal areas drilled in California to November, 1962.

Figure 14.--Thermal areas, California--Continued

(p. 62 follows)

Godwin, L. H., Haigler, L. B., Rioux, R. L., White, D. E., Muffler, L. J. P., and Wayland, R. G., 1971, Classification of public lands valuable for geothermal steam and associated geothermal resources: U.S. Geol. Survey Circ. 647, 18 p.

Index of "known geothermal resource areas" (KGRA) and areas valuable prospectively as of December 24, 1970. Includes classification factors and a copy of the "Geothermal Steam Act of 1970."

Hose, R. K., and Taylor, B. E., 1974, Geothermal systems of northern Nevada: U.S. Geol. Survey open-file report (74-271), 27 p.

Hulin, C. D., 1925, Geology and ore deposits of the Randsburg quadrangle, California: California State Mining Bur. Bull. 95, 152 p.

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Part I. List of 15 sites drilled to November 1962. Includes Randsburg, San Bernardino County; Tecopa, Inyo County. Descriptions of The Geysers, Sonoma County; Casa Diablo Hot Springs, Mono County; Salton Sea thermal area, Imperial County.

Part II. Problems of natural steam exploration and development

Norman, L. A., Jr., and Stewart, R. M., 1951, Mines and mineral resources of Inyo County: California Jour. Mines and Geology, v. 47, p. 17-223.

Sass, J. H., Lachenbruch, A. H., Munroe, R. J., Green, G. W., and Moses, T. H., Jr., 1971, Heat flow in the Western United States: Jour. Geophys. Research, v. 76, no. 26, p. 6376-6413.

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Dibblee, T. W., Jr., and Gay, T. E., Jr., 1952, Geology and mineral deposits of the Saltdale quadrangle: California Div. Mines Bull. 160, 66 p.

Eric, J. H., 1948, Copper in California: California Div. Mines Bull. 144, pt. 3, p. 199-357.

Tabulation of copper deposits of California listing production (class), name, owner, location, remarks, and references. Of the 309 deposits in San Bernardino County, three are in the subject area--see under COPPER herein.

Foshag, W. F., and Woodward, A. O., 1936, Bentonitic magnesian clay-mineral from California: Am. Mineralogist, v. 21, p. 238-244.

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Fournier, R. O., White, D. E., and Truesdell, A. H., 1974, Geochemical indicators of subsurface temperature--Part 1, Basic assumptions: U.S. Geol. Survey Jour. Research, v. 2, no. 3, p. 259-262.

Gale, H. S., 1946, Geology of the Kramer borate district, Kern County, California: California Jour. Mines and Geology, v. 42, no. 4, p. 325-378.

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Lake County period (1864-72)
Playa period (1872-90)
Colemanite period (1890-1907)
Death Valley period (1907-1927)
Kramer period (1927-present)

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Lists warm (80°F) sulfur spring (Sec. 10, T. 21 S., R. 44 E., MDBM) in Panamint Valley - 4 miles north of Ballarat.

_____ 1965, Thermal springs of the United States and other countries of the world: U.S. Geol. Survey Prof. Paper 492, 383 p.

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Woolard, G. P., and Joesting, H. R., 1964, Bouguer anomaly map of the United States: Am. Geophys. Union and U.S. Geol. Survey.

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Offset 30-40 miles left lateral.

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